PROJECT MONOGRAPH

Leatherwood Creek Project Ind-1
Bedford, Indiana Region 3

Soil Conservation Service
U. S. Department of Agriculture
Washington, D. C.

CONTENTS

INTRODUCTION

The Leatherwood Creek watershed, Lawrence County, was the first Soil Conservation Service demonstration project to be located in Indiana.

This monograph is a presentation of the work of the Soil Conservation Service with cooperating farmers and the results of the erosion control program established on Leatherwood Creek watershed.

The period of time that has elapsed since the program started in 1935 has been too brief to determine definite results on all phases of the work. It is possible, however, to give a description of the area, the planned program of adjustments in land use and erosion control practices and the methods of procedure, and installation of such practices on farms. From the results accomplished, some definite conclusions can be drawn.

Information presented herein has been obtained by the technical staff of this project from experience, from special studies, tests, surveys and observations of treatments and practices used, combined with information from experimental work, with the hope that it will prove helpful to those who are interested in the practical, effective and economical conservation of soil and moisture in districts where the soil, climate and agriculture are similar.

THE AREA AS NATURE MADE IT

A Land of Hills and Valleys

Leatherwood Creek watershed is an area of approximately 26,000 acres, located in the northeast part of Lawrence County, Indiana (fig. 1). The maximum width is 5.2 miles, the length 14 miles.

It is drained by Leatherwood Creek, consisting of the north and south forks, which empties into the east fork of White River.

The watershed is within that portion of southern Indiana which was not covered by glaciers, as shown in Figure 2; therefore, the land has long been subjected to the weathering action of the elements and running water. The forces of nature have produced a thin layer of soil which now covers the underlying system of rocks, known as Mississipian limestones. The most widely known of these limestones are the Mitchell, Harrodsburg and Oolitic. The superior qualities of the Oolitic stone for building purposes are generally recognized.

The landscape which comprises the watershed falls into two merging physiographic divisions based chiefly on topographic conditions, namely the Norman Upland and the Mitchell Plain (4)[1].

Topography in the northeast portion of the watershed is representative of the Norman Upland. A characteristic of the topography in this section is the more gentle slopes southward, with abrupt, steep slopes to the north, bordering the narrow, dissecting stream valleys.

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[1]Figures in parenthesis refer to literature citations on page 216.

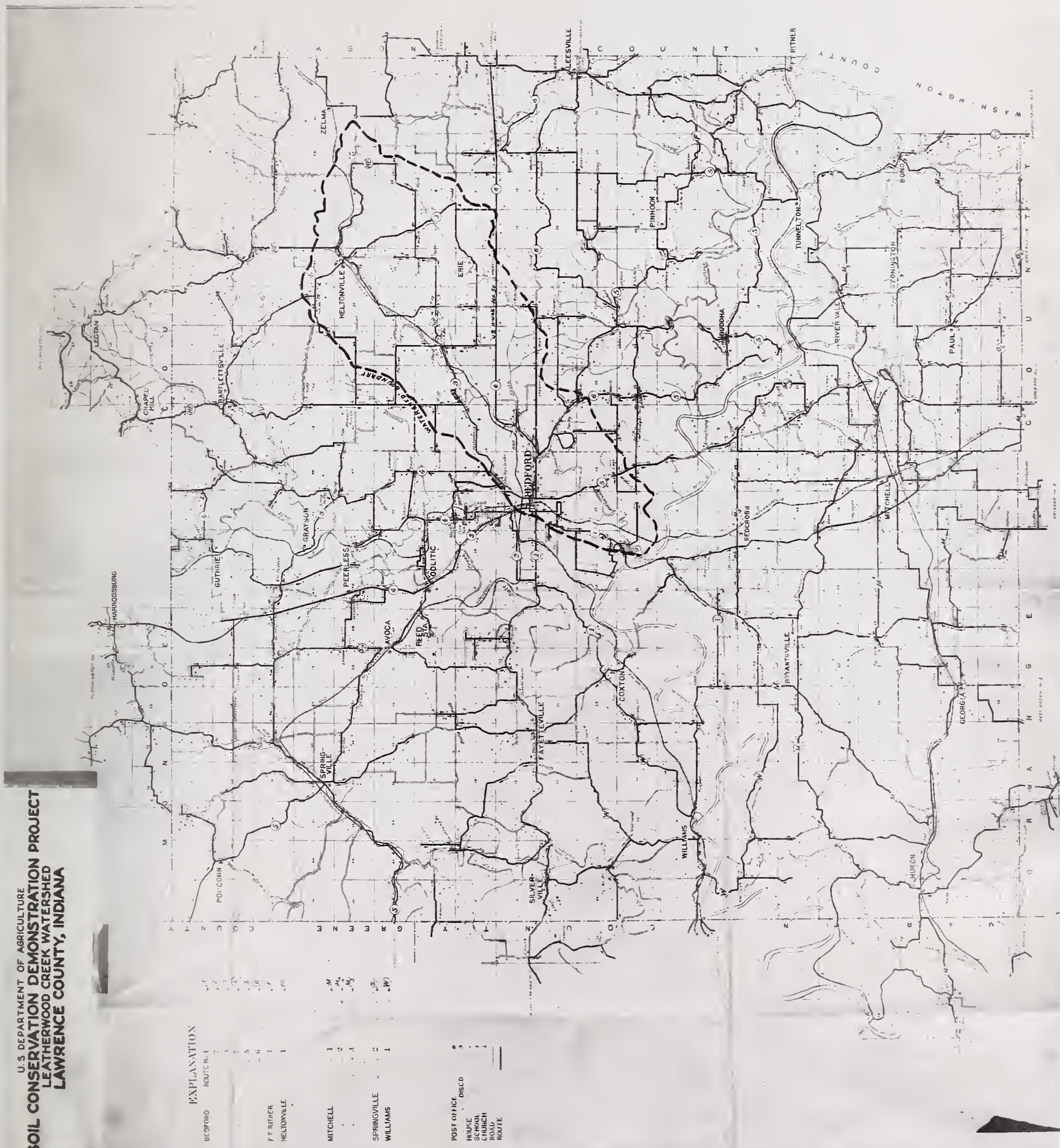

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION DEMONSTRATION PROJECT
LEATHERWOOD CREEK WATERSHED
LAWRENCE COUNTY, INDIANA
EXPLANATION
BEDFORD
FT RITNER
HELTONVILLE
MITCHELL
SPRINGVILLE
WILLIAMS
POST OFFICE
HOUSE
SCHOOL
CHURCH
ROAD
ROUTE
BEDFORD
MITCHELL
HELTONVILLE
OOLITIC
LEESVILLE
TUNNELTON
BARTLETTSVILLE
HARRODSBURG
GUTHRIE
AVOCA
SPRINGVILLE
FAYETTEVILLE
WILLIAMS
HURON
COXTON
PINHOOK
GEORGIA
ZELMA
ERIE
GRAYSON
PEERLESS
BUDDHA
REDCROSS
BRYANTSVILLE
STONINGTON
RIVER VALE
PAUL
BOND
RITNER
LEATHERWOOD CREEK WATERSHED BOUNDARY

Figure 1.

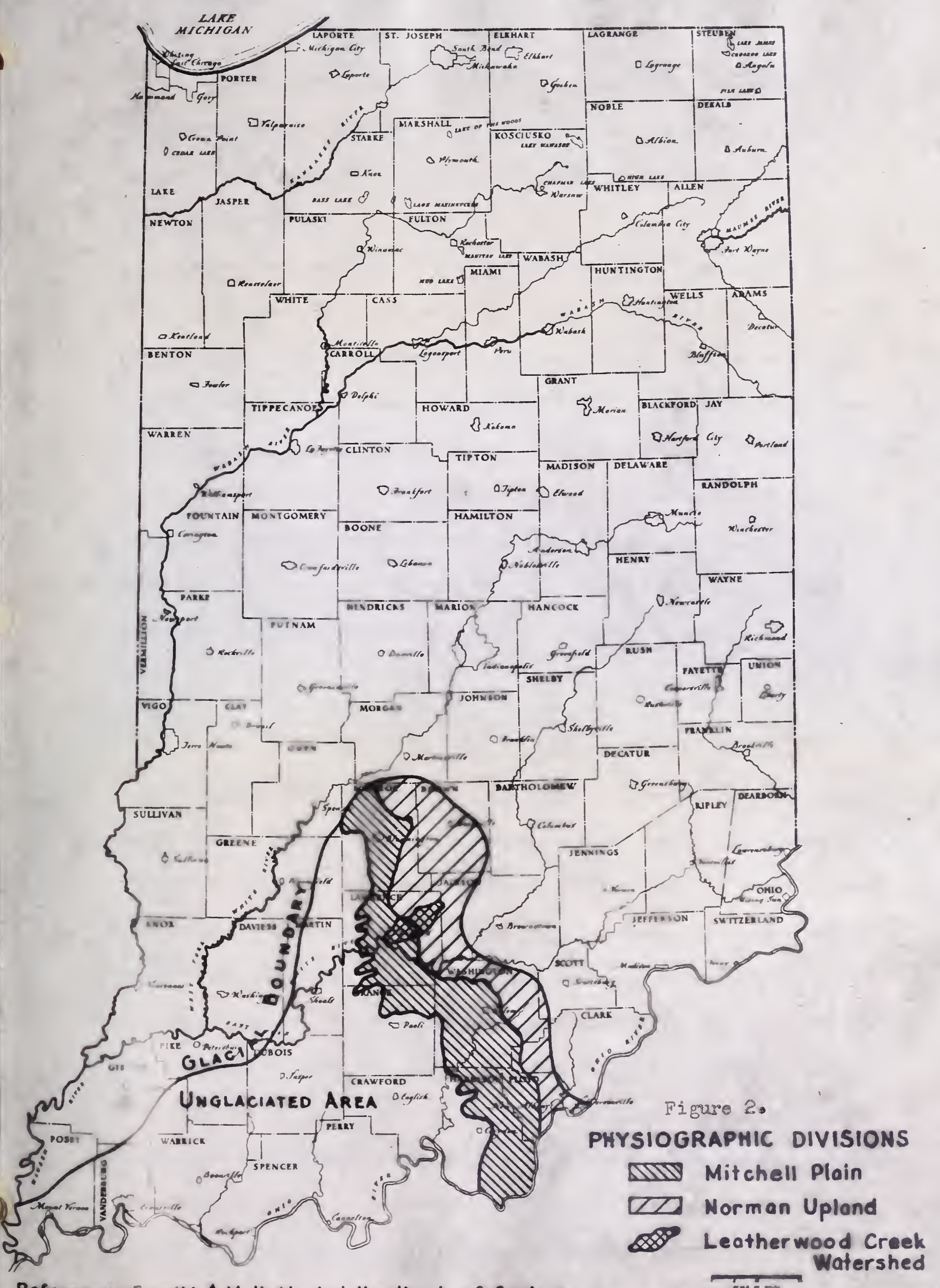


Figure 2.

Reference : Everitt & Mallott Ind. Handbook of Geology

A maximum elevation of 800 feet is reached in the eastern part of the watershed. Immediately underlying the surface is a strata of shale and sandstone of fine grain texture forming a cap rock over the limestone.

The western portion of the watershed lies mostly within the Mitchell Plain. The topography of this portion is influenced by the strata of limestone beneath the surface. Figure 3 shows a typical view of the Mitchell Plain topography in the watershed. It is more uniformly rolling, with some broken land bordering the creek valleys. As is characteristic of limestone regions, sinkholes are found between the surface waterways, and springs are common. Mitchell limestone outcrops on steep slopes, and the streams are down to rock bottoms. The soil varies in thickness from a few inches to several feet.

The Land Brought Forth Every Living Thing

Growing in the moist silt loam which had formed through the ages was a mixed vegetative cover of trees, shrubs, vines and plants. When the first white men came to this section, they found a land covered with unbroken forests of the beech, maple, tulip poplar type with walnut, ash, hickory, oak, cherry and chestnut covering the slopes and ridge crests. Records indicate that poplar and walnut trees reaching a height of more than 100 feet and a diameter of 4 or 5 feet were not uncommon in this area. Associated with these forest trees were shrubs and herbaceous plants such as spicewood, witch-hazel, dogwood, viburnum and grapes. The area received its name from the luxuriant growth of Leatherwood shrubs along the creek.

Figure 3. A view looking southeast across the Leatherwood Creek watershed, from a point on State Road 58. This Mitchell Plain topography was originally covered with luxuriant forest.

An abundance of wildlife was found in this environment. Some of the mammals known to have been in the area were opossum, shrew, raccoon, weasel, mink, otter, skunk, fox, wildcat, squirrel, muskrat, rabbits, deer and black bear. Birds then numerous but extinct now were passenger pigeon, wild turkey and ruffed grouse. Other birds present were those known in this part of Indiana today. Amphibians, reptiles and fish were also numerous. Fishing was good in the water holes along Leatherwood Creek, which was fed by numerous excellent springs, when settlers first came.

There Was Not a Man to Till the Soil

Historians record that Indian camp grounds were located near the present site of Heltonville, on the bluffs and within easy access of water. Only wandering bands used these camp sites, most likely on hunting and fishing expeditions.

No disturbance of the vegetation had occurred when settlers first came, except by the animals and birds and trails made by roving Indians.

THE AREA AS MAN USED IT

The Land Was Subdued

The first settlers in the area were of Scotch and Irish descent, coming from Kentucky, Virginia and North Carolina. Records indicate that this section was first visited by white men in 1816; the first settlement was made in 1817 on the south fork of Leatherwood Creek in Section 1 of Shawswick Township. Hunters and trappers were attracted by the abundance of game animals which were associated with the forests and streams.

Men with families came to build homes in the wilderness and saw the magnificent timber as material for shelter and fuel. Numerous springs bubbling from the earth were a source of water, and the fertile land which produced so abundantly was a land on which white men could live.

Pleasant Run Township, in the eastern part of the watershed, was formed when the county was organized in 1818. In 1820, 23 land entries had been made in the township, half of which were within the Leatherwood Creek watershed.

Shawswick Township was one of the first five in the county. Eighty-six land entries had been made in this township by 1820, reflecting to some extent the attractiveness of this part of the watershed (2).

That Leatherwood Creek was a more continuous flowing stream when the area was first settled than now is indicated by the water mills of various types which were located along the stream. Early in the 1820's, a water power sawmill was located about a mile and a half southeast of Bedford. In a short time another sawmill was located above this, operating for a number of years. Near Erie, a water power grist mill was built in 1832, and for several years did an extensive business. Sites of some of these mill locations are evident today, as rock dams were constructed for ponding water to operate the mills. See Figure 4.

Figure 4. Water power grist and sawmill restored and in operation in Spring Mill State Park, Lawrence County.

Bedford, the county seat, located in the southwestern part of the watershed, was founded in 1825. A few industries were started here early, utilizing the products of forest and soil. Among the first industries were a distillery; tannery; woolen factory; cabinet and coffin factory; a hattery, making hats from furs of mink, otter, beaver, coon, and other animals. Sawmills, a flour mill, and a pork packing plant were also among the first industrial ventures using products of the soil. These industries were an inducement for the settlers to clear land, kill the game, and grow more crops. Corn was evidently the first crop produced commercially. Flat boats built on nearby White River and Salt Creek were used to ship grain, flour, whiskey and pork as far as New Orleans. The boats were often sold along with the cargo.

Bluegrass was first brought into the area in 1820, from Kentucky, by Stever Younger, a pioneer settler in the vicinity of what is now Leatherwood Church. It has grown to be one of the leading pasture grasses in Indiana, and has had much to do with the livestock and dairy enterprises in the farming systems of the area. Bluegrass began to replace trees as a vegetative cover for the land, and many acres which were cleared and cropped for a few years were allowed to come into bluegrass for pasture.

W. C. Latta (3) in his "Outline History of Indiana Agriculture" states that "throughout the first half of the nineteenth century and even later, unconscious or at least unintentional, soil exploitation was practically universal throughout the state. With the growing volume of production, soil impoverishment was accelerated. At first, worn fields could be left to undergo a slow, natural renewal while freshly cleared new ground was available. As the area of virgin soil diminished, however, more constant cropping became the rule, varied only by the occasional resting of a field during one season, called summer fallowing. With the advent of the cast-iron plow about 1830, the steel and subsoil plow a decade or two later and the chilled plow in 1855, deeper and more thorough tillage was employed to maintain crop yields. The ill effects of pioneer farming became increasingly manifest on the older farms of the state, but were most strikingly shown on the hill lands of southern Indiana."

The town of Heltonville was platted in 1845, by Andrew Helton, although he had opened a store there in 1839. A tannery was one of the early industries at Heltonville, utilizing chestnut and oak bark and pelts of the wild and domestic animals. This section of the watershed was covered by a luxuriant growth of timber. Development was slow because of lack of transportation facilities. In 1849-50, the principal products marketed were butter, eggs, poultry and tallow. Butter was exchanged at 8 to 10 cents per pound, eggs at 6 to 9 cents per dozen, chickens 10 cents each and clover seed $5 per bushel, according to an old ledger from a Heltonville general store. Changes in size of farms from this period to the present is an interesting economic consideration in its effect upon the number of farms and the resulting intensity of land use. See table 1.

Table 1. Contrast in size of farms and assessed value, showing percent change from 1846-1936.

	Year		Change
	1846	1936	percent
Size farm, acres			
320-over	15	1	-93
160-320	39	40	2
80-160	42	85	+102
80-less	53	110	+107
No. of farms	149	236	+58
Assessed value			
Pleasant Run Twp.	\$2-\$5/A	\$5-\$20/A	300
Shawswick Twp.	\$2-\$10/A	\$10-\$45/A	400

The Old Order Changes

Changes mark the path of progress in agriculture, even as in other pursuits and occupations.

The advent of the railroad into this territory provided an outlet for products of the land. The variety and volume of land products increased rapidly. It appears that the self-sufficing type of agriculture changed to a commercial type about 1870. The pioneer railroad was constructed through Lawrence County in 1851-1853. The second road was built in 1855-1857. The Bedford-Bloomfield railroad was contracted for in 1874. These roads were financed largely by local capital with right-of-way donated and a tax on the townships through which the lines were run. Along with the railroads came county roads.

Heltonville became an important concentration and shipping point for timber products, especially cross ties. The practice of trading ties for merchandise was common. Fifty thousand ties have been a normal annual shipment from this station. There is one permanent sawmill in Bedford and at least two small portable outfits sawing in the project area at present. However, little timber is being cut to support these mills.

Corn and oats were the principal grain crops. Timothy and clover were seeded in the oats for hay. The census reports of 1870, compared with 1935 for Shawswick Township, show that approximately as much corn was produced in this area in 1870 as now, although the land in farms was 25 percent less. This is an indication of the productivity of the soil 65 years ago.

As the area devoted to corn increased, it became a common practice to rake corn stalks into windrows and burn them in order to clear the field for successive crops. Fields which had been idle temporarily were burned off to destroy weeds. Leaves and brush were burned to clear new ground. This wholesale destruction of organic matter was taking a toll on the inherent moisture holding capacity of the soil. Probably the first unfavorable condition noticed by the farmer was some gully erosion and the loss of mellowness of the soil. Farmers permitted the gullied fields to grow up in briers and weeds. After a few years the gullies were plowed in and the fields cropped again.

The first grain binder was used in the area about 1890. Previous to this time a limited amount of wheat had been grown. The binder probably contributed to a more diversified type of farming, as meadows were seeded in the larger acreage of small grains.

More forage consuming livestock were introduced. Some farmers made a practice of feeding out herds of cattle which they would accumulate from nearby growers, thus converting forage and grain into more valuable animal products. While the mixed type of farming was becoming a more common practice, there were exceptions to the practice on farms operated on the share or cash-rent system of tenancy. In some instances this type of farming resulted in ruin to the land and the owner.

An industry of great importance to this area, which entered the picture in the early nineteen hundreds, was the commercial use of limestone for building purposes. The advantages of "Bedford stone" in construction came to the attention of builders throughout the nation and shipments were made to foreign countries. The period of development of stone quarries and construction of mills from 1900 to 1926 was a period of industrial activity which had a stimulating effect on the social and economic life of this area. The increase in population of Bedford and nearby towns created a demand for farm products which had not existed before. In 1900 the population of Bedford was about 9,000 and in 1930, 16,000. Dairying and poultry raising developed into more important farming enterprises in the area.

The demand for labor in the limestone industry drew farmers and farm labor from the poorer farms into town. This trend was beneficial insofar as intensive farming in many instances was replaced by part-time farming, and labor scarcity reduced the acres which could be cultivated. Another economic and social effect was the purchase of small farms by industrial workers during this period of high wages. This situation helped the average farmer through the agricultural depression period, 1920-1930. However, the general depression period, 1930-36, threw these landowners out of industrial employment, back to the land, which resulted in intensive farming in many cases.

Data compiled from census reports for Lawrence County shows there has been but slight change in the corn acreage since 1870. The acreage and yield of oats have decreased. The acreage of wheat has declined slowly within recent years.

Although corn is the most extensively grown crop, local demand consumes more than local supply.

According to the Soil Survey Report of Lawrence County, by Tharp, Bushnell and Adams (7), "Bluegrass is well distributed throughout this area and would probably become the dominant growth on the brown alluvial soils were these not so generally in cultivation. This valuable pasture grass seems less abundant than formerly and its weak growth or entire absence in many pastures is noticeable. This may be due to overgrazing, lack of humus in many old fields and in some measure to soil acidity. During the dry season of 1922, scanty growths of lespedeza were observed in parts of the county."

The census returns for 1879 report an expenditure in the county of $10,518 for commercial fertilizer. The first commercial fertilizer was used in the project area in 1880, according to reports of old residents.

The first Lawrence County agricultural agent in his report for 1917 says, "Nature has made our soil a serious problem, and it can best be met by the increased production of legumes, especially alfalfa, the establishment of many soils into good permanent pastures to prevent soil erosion ..... the application of limestone and phosphate fertilizer. Alfalfa acreage has been increased in the county from 800 acres in 1915 to 5,000 acres in 1917. This large increase in alfalfa acreage resulted from demonstrations and special work towards the establishment of the crop in Lawrence County.

"When war was declared in April 1917, a series of increased production meetings were held in the county .....As a result, the wheat acreage was increased 35 percent, the rye acreage 20 percent, the corn acreage 24 percent above the past year."

The 1919 report states that 500 tons of commercial fertilizer and 1,000 tons of agricultural limestone were used in the county.

Limestone was first used in the project area about 1909. It is reasonable to assume that the use of better practices, including liming, fertilizing and growing alfalfa, kept pace in the project area with the county as a whole. In 1919 there were 6,400 dairy cows in the county with 8,700 beef cattle. Seventy-nine and two-tenths percent of the farms were operated by owners, 1 percent by managers, 19.8 percent by tenants.

The first creamery buying milk wholesale and selling retail in Bedford was started about 1915. Now there are two creameries in Bedford, taking whole milk and cream from producers in the area and manufacturing dairy products.

Education facilities in the area rank high, with three high schools -- in Heltonville, Bedford and Shawswick Township. With good roads and school bus transportation they are within reach of all farm children. An important part in rural life and education in conservation work has been played by 4-H clubs.

It is possible to visualize partly the great changes in natural conditions of the soil, vegetation and animal life which have occurred in the area as a result of the agricultural, economic and social demands made by men.

The records show that 25 to 50 percent of the original soil has gone where primeval forests once flourished, dry stream beds glare in the summer sun where flowing springs once watered them, numerous species of vegetation and animal life have been eliminated and substitutions made, all within the past 100 years of settlement and human occupation.

The limit has probably been reached in this exploitation period. Residents of the area must now by study of the conditions try to recognize and solve the problems of land use.

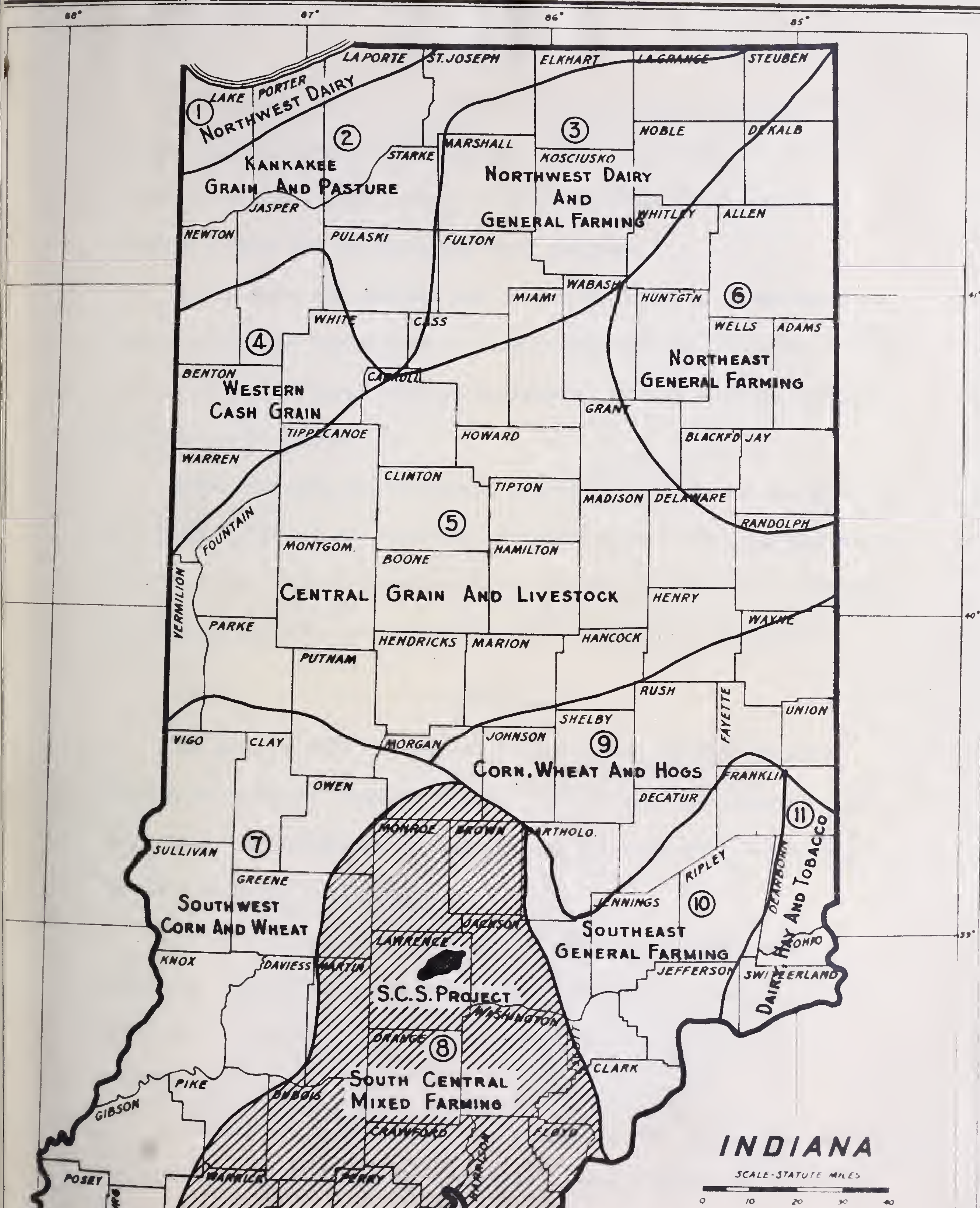
THE AREA AS FOUND BY THE SERVICE

Selection

The Leatherwood Creek watershed was selected as a suitable demonstration area after consultation with various state agencies interested in the major objectives of the Service. The main purpose of the project was to aid cooperating farmers in bringing about proper adjustments in land use, followed by adoption of effective methods for soil and moisture conservation.

Cooperative action between farmers and the Service tests erosion control measures under actual conditions for effectiveness, practicability, and economic soundness. In addition, it affords opportunity for improvement of measures.

Leatherwood Creek watershed was a well defined area for such a project. Its topography, soil types, climate and types of farming were representative of part of the unglaciated area in southern Indiana, where moderate sheet erosion and occasional-to-frequent small gully erosion have caused widespread damage. Figure 5 shows the project area in respect to the type of farming area in which it is located (10).



88°
87°
86°
85°
41°
40°
39°
38°
LAKE
PORTER
LAPORTE
ST. JOSEPH
ELKHART
LAGRANGE
STEUBEN
1 Northwest Dairy
2 Kankakee Grain And Pasture
3 Northwest Dairy And General Farming
NOBLE
DEKALB
STARKE
MARSHALL
KOSCIUSKO
JASPER
NEWTON
PULASKI
FULTON
WHITLEY
ALLEN
MIAMI
WABASH
HUNTGTN
6 Northeast General Farming
WHITE
CASS
WELLS
ADAMS
4 Western Cash Grain
BENTON
CARROLL
GRANT
TIPPECANOE
HOWARD
BLACKFD
JAY
WARREN
CLINTON
TIPTON
MADISON
DELAWARE
RANDOLPH
FOUNTAIN
5 Central Grain And Livestock
MONTGOM.
BOONE
HAMILTON
VERMILION
HENRY
PARKE
WAYNE
HENDRICKS
MARION
HANCOCK
PUTNAM
RUSH
FAYETTE
UNION
SHELBY
VIGO
CLAY
MORGAN
JOHNSON
9 Corn, Wheat And Hogs
FRANKLIN
OWEN
DECATUR
MONROE
BROWN
BARTHOLO.
11 Dairy, Hay And Tobacco
SULLIVAN
7 Southwest Corn And Wheat
RIPLEY
GREENE
JENNINGS
10 Southeast General Farming
DEARBORN
JACKSON
LAWRENCE
OHIO
KNOX
DAVIESS
MARTIN
JEFFERSON
SWITZERLAND
S.C.S. Project
WASHINGTON
ORANGE
8 South Central Mixed Farming
SCOTT
CLARK
PIKE
DUBOIS
GIBSON
CRAWFORD
FLOYD
HARRISON
POSEY
WARRICK
PERRY
VANDERBURG
SPENCER
INDIANA
SCALE-STATUTE MILES
0 10 20 30 40
Types of Farming Areas
1. 1926

Figure 5.

An economic and social problem in this community contributed to the desirability of locating the project in Bedford. Reduced activity in the stone industry during the depression years had created a need for an emergency work program.

In locating the project and office in Bedford, consideration was given to the convenience of administrative and technical supervision of 11 CCC camps engaged in erosion control work in southern Indiana at the time.

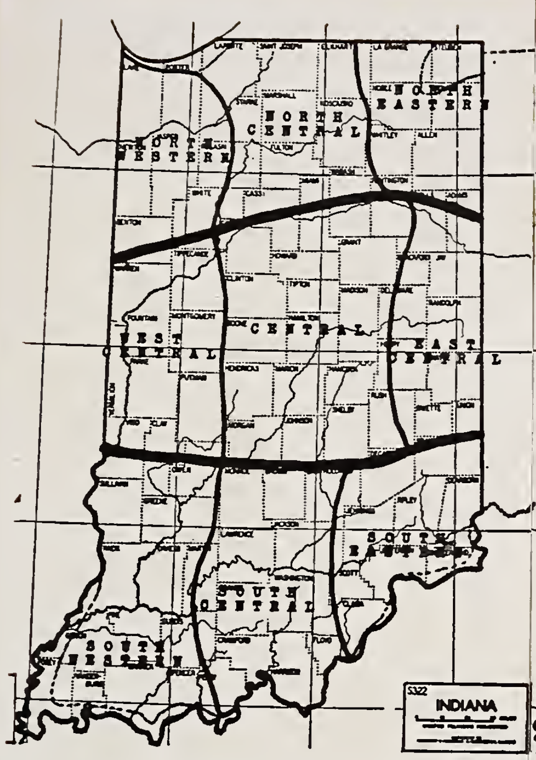
After the area was selected, a project manager was designated, who with technical and clerical personnel began work. Aerial photographs of the watershed were made to provide the basis for surveys and studies of erosion conditions and agricultural practices.

The Climate

The project area is located in the south central climatic region in Indiana. Figures 6A, B, C and D show the climatic subdivisions now recognized in Indiana and rainfall data pertaining to this climatic region (8).

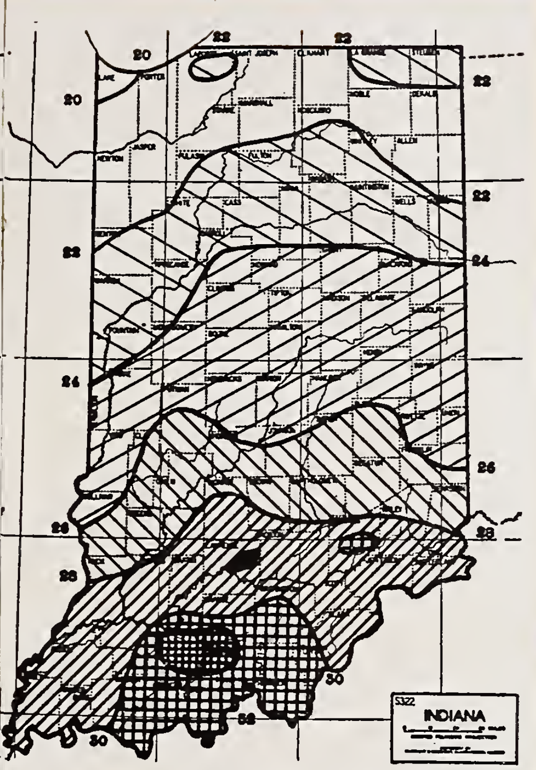
Data on rainfall intensity are significant in the study of erosion. Intensity may be more important than the amount since an excessive short rain cannot be absorbed rapidly by the soil in this area.

Rainfall and temperature data adaptable for use on the Leatherwood project were available from a Weather Bureau Station on the Purdue Station Farm, near Bedford and are shown in table 2.



—*Indiana climatic regions and subregions*

Figure 6A.



—*Distribution of precipitation from October to May*

Figures show total inches, based on all avail-

Figure 6B.

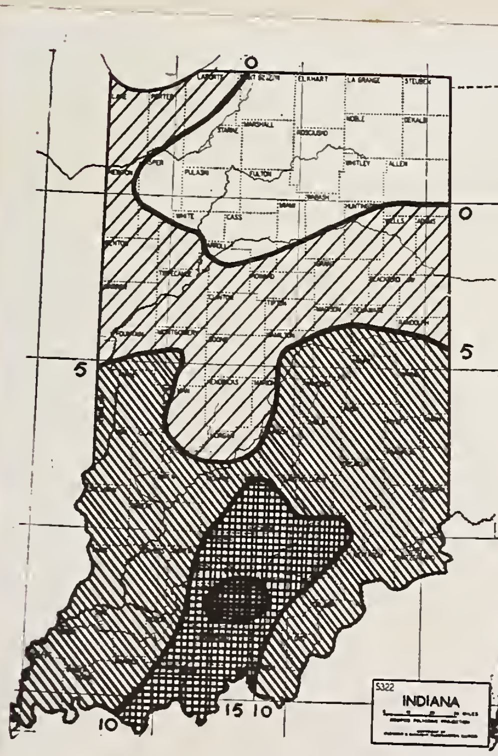


Fig . Four-day rains of six inches or more. Percentage of years with such.

Figure 6C.

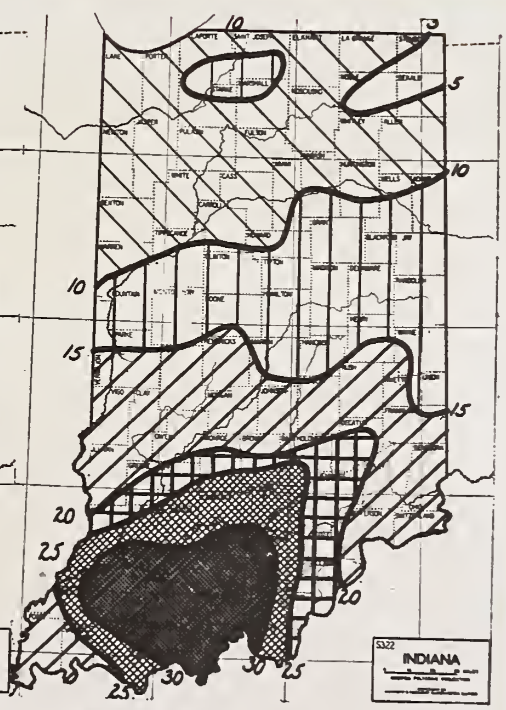


Fig. . Daily rains of one inch or more, in winter. Times per decade.

Figure 6D.

Table 2. Average monthly and annual rainfall and temperature at station near Bedford, Indiana. Twenty-year record.

Month	Rainfall inches	No. days with more than .01 in.	Average rainfall per rain	Snowfall inches	Average tempera-ture
January	3.30	8	.41	3.5	31.6
February	2.82	8	.35	3.7	33.2
March	4.02	8	.50	1.3	44.2
April	3.89	8	.49	0	54.1
May	3.63	9	.41	0	63.9
June	4.10	9	.46	0	73.5
July	2.58	6	.43	0	77.1
August	3.83	7	.54	0	75.5
September	3.47	7	.50	0	68.9
October	3.78	6	.63	0.3	57.3
November	3.55	7	.51	0.4	45.1
December	3.75	8	.47	3.3	35.0
Total	42.72	91		12.5	54.9

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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The average rainfall is shown to be 42.7 inches with 52.7 percent falling in the growing season, from April to September. Low rainfall and high temperature in July and August are detrimental to crops and permanent pastures. The periods of heavy rainfall in October, November and January are a factor for consideration since at this season vegetation is inadequate for protection or may not be present at all. The frequent occurrence of heavy rains in the spring, during seed bed preparation, is an important factor when entire slopes are exposed by plowing. The quantity of rain which falls during each rain and the period in which this rain falls is of extreme importance in an erosion control program, as the ways and means of controlling and retarding run-off by the use of vegetation changes with the seasons.

Reports show that within the past 20 years at Bedford, periods of intense rain occurred, ranging from 1 to 2.5 inches during an hour. The mean annual temperature at Bedford is 54.2°. The mean maximum is 88.3° in July, the mean minimum is 22° in January, a range of 60.3°. The average date of the last killing frost in spring is April 18. The average date of first killing frost in fall is October 14, providing an average growing season of 180 days. The snowfall is comparatively light, and the ground is covered an average of 15 days per year. Alternate freezing and thawing loosens the soil and plants winter kill easily as a result of heaving. These climatic conditions are important considerations in combating soil loss from erosion.

There have been unusual weather conditions, which have contributed to erosion conditions, such as the abnormally heavy rainfall in March, April and May of 1927 when 22.3 inches of rain fell; January 1937 when rain fell for 14 days, a total of 14 inches for the month.

Periods of prolonged drouth, which destroy vegetation, occur at intervals exposing the land to the erosive action of rainfall. The drouth of 1930, with only 27.8 inches for the year, was the driest on record.

The Conservation Survey

The conservation survey was a physical land inventory, showing the land conditions existing at the time of survey. It gave four major kinds of data:

(1) Amount and kind of erosion

(2) The kind of soil, or the soil types

(3) The degree of slope

(4) Present use of the land, as cultivated, pasture, timber or idle.

The field survey was on a scale of 10 inches equals 1 mile, and the base maps used were aerial photographs. Field work was started October 15, 1935 and completed in June 1936. Actual field information was obtained by walking close enough to see all surface features and to study all soil conditions. The resulting conservation survey map showed conditions having a practical application for farm planning. The following is a field legend used at the time of mapping.

Legend for conservation survey maps.

SLOPE

A	0-3%
B	3-8%
BB	8-12%
C	12-20%
D	20% and over

ORDER OF SYMBOL

$$\frac{\text{Soil type - land use}}{\text{Slope - erosion}}$$

or

$$\frac{34 - P}{BB - 3}$$

SHEET EROSION

1. No apparent erosion
2. Up to 25% topsoil removed
3. 25-50% topsoil removed
4. 75-100% topsoil removed
5. Sheet erosion into parent material.

GULLY EROSION

7. Less than 3 gullies per acre
8. More than 3 gullies per acre

(7) (8) (9) Cannot be crossed by machinery

7V, 8V, 9V. Penetrated "C" horizon

LAND AND CROP USE

P	-Pasture
P2	-Good pasture
P3	-Fair pasture
P4	-Poor pasture
F	-Forests
F1	-Young growth
F2	-Second growth
F3	-Selection woods
F4	-Old growth
F5	-Cut over area
X	-Idle land
X1	-Idle cultivated land
X4	-Brush land
Lo	-Fallow land
L11	-Alfalfa
L13	-Sweet clover
L15	-Lespedeza
L22	-Clover meadow
L33	-Grass meadow
L4	-Row crops
L5	-Close-growing winter crops
L6	-Close-growing summer crops
L7	-Horticultural crops

The soil type legend shown below differs slightly from the original field legend due to the final correlation of soil types. The soil types shown are in accordance with the correlation.

33	Bedford silt loam
4	Hagerstown silt loam
6	Hagerstown stony silt loam
5	Hagerstown silt loam, shallow phase
31	Guthrie silt loam
32	Lawrence silt loam
34	Dunmore silt loam
46	Muskingum silt loam
42	Tilsit silt loam, valley phase
24	Monongahela silt loam, colluvial phase
26	McGary silt loam
94	Princeton fine sandy loam
54	Huntington silt loam
55	Huntington very fine sandy loam
63	Melvin silt loam

Figures 7A and 7B show an aerial photograph of a portion of the watershed with accompanying mapping symbols and the same area as photographed on the ground.

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Fig. 7A – Aerial Photograph of a Portion of the Leatherwood Creek Watershed. Conservation Survey Data shown as $\frac{\text{Soil-Land Use}}{\text{Slope-Erosion}}$.

Fig. 7B – Same Landscape as shown in Aerial Photograph. Corresponding Numbers as Ⓘ, Ⓘⓘ, represent Identical Ground Points.

Erosion.

Two kinds of water erosion were mapped, sheet and gully. Sheet erosion is the removal of a more or less uniform layer of soil material by water action. Classes of erosion with sumbol numbers are defined in conservation survey legend. Gully erosion is the formation of definite waterways or channels that are not obliterated by normal tillage operations. Sheet erosion is determined by comparison of the depth of topsoil on uncleared or virgin forest areas with areas subject to cultivation, compared under similar degrees of slope and soil type. Gullies were mapped as described above. The gully symbols 7 and 8 were always used in conjunction with sheet erosion symbols, as 37 - 48. Symbol 9 was used alone.

The acreage and proportionate extent of the various classes and degrees of erosion as revealed by the conservation survey on the watershed are shown by data on table 3. These data indicate that an average of 3 inches of topsoil has been lost from the sloping, cultivated land since farming began in the watershed, less than 100 years ago. Three inches of topsoil per acre represents about 400 tons. An illustration of sheet erosion on the ridge and slopes with gullies forming in the natural depressions is shown in Figure 8.

Table 3. Acreage and extent of the classes and degree of erosion in the Leatherwood Creek watershed area.

Class and type symbol	Degree of erosion	Acres	Percent
1	No apparent erosion	270	1.1
+	Recent deposits	190	.8
2,27	Slight erosion	13,743	54.9
3,37	Moderate erosion	7,843	31.3
38,33,337	Moderate to severe erosion	2,248	9.0
338,4,47	Severe erosion	597	2.4
48,9	Very severe erosion	137	.5

Figure 8. A field near Bedford, showing all types and degrees of erosion resulting from lack of control measures.

Soils.

Soils are classified on characteristics found within the soil body. Soil forming forces influence characteristics, but the classification criteria are the characters found within the soil. When similar characteristics, such as number and thickness of horizons, texture (except surface texture), parent material, and associated factors are found to be similar, the unit of classification is called soil series.

Soil type differs from soil series only in the surface texture. The soil type is the unit used for detailed mapping. The important soils mapped within this area are residual from limestone, that is weathered from the rock in place. For the most part, they are deeply weathered or leached. Two major groups or catena are recognized:

1. Soils derived from pure limestone (absence of chert)

2. Soils derived from impure limestone (presence of chert)

In addition to these groups are found a residual sandstone group, first and second bottom soils and a small area of wind-blown sand. Important characteristics and extent of soil types mapped in the watershed are shown by data in table 4.

Typical profiles of the two major groups are shown in figures 9A and 9B.

Table 4. Important characteristics and distribution of soil types in Leatherwood Creek watershed.

Soil type[1]	Legend Symbol	Origin	Topography	Natural drainage	Acres in area	Percent
Bedford silt loam	33	Impure limestone	Gentle slopes	Intermediate	7,903	31.6
Hagerstown	4	Pure limestone	Rolling	Well drained	6,072	24.3
Dunmore	34	Impure limestone	Hilly sinkholes	Well drained	4,231	16.9
Huntington	54	First bottom land	Level to gently sloping	Well drained	1,474	5.9
Lawrence	32	Impure limestone	Gentle slopes	Imperfect	1,275	5.1
Muskingum	46	Sandstone & shale	Narrow ridges steep slopes	Well drained	1,156	4.6
Hagerstown stony	6	Pure limestone	Steep slopes	Well drained	802	3.2
Linside	52	First bottom	Level	Imperfect	404	1.6
Guthrie	31	Impure limestone	Level	Poor	365	1.4
Huntington very fine	55	First bottom	Gently sloping	Well drained	336	1.3
Hagerstown shallow	5	Pure limestone	Gentle slopes	Well drained	318	1.3
Tilsit valley phase	43	Sandstone & shale	Gently rolling	Intermediate	291	1.2
Princeton fine sandy loam	44	Loess	Rolling to hilly	Well drained	219	.9
McGary	25	Second bottom terrace	Level	Imperfect	140	.5
Monongahela	24	Second bottom terrace	Level	Well drained	42	.2
					25,028	100.0

[1]All soil types are silt loams except Princeton fine sandy loam and Huntington very fine sandy loam.

Figure 9A. Typical profile of Hagerstown silt loam.

Figure 9B. Typical profile Guthrie silt loam.

Slope.

The degree of slope or the steepness of the land is determined in the field by the use of an Abney hand level. The percent of slope is read directly from the scale on the instrument. By percent of slope is meant the rise or fall of a land surface in a given 100 feet. For example, if there is a difference of 5 feet in elevation between two points (100 feet apart), the percent of slope is 5 percent.

Since slope conditions are so closely related to run-off and erosion, and also farming practices, the following slope classification, limits and their definitions were used, being designated in the symbol by capital letters A, B, BB, C, D. All slope conditions were determined in the field at the time of mapping in conjunction with the other factors[2].

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[2] Definitions taken from "Procedure for Making Soil Conservation Surveys".

A, 0-3 percent -- Comparatively level areas upon which there will be a minimum of erosion under normal conditions of tillage.

B, 3-8 percent -- That range of slope above the A group upon which, under prevailing conditions of use, erosion is active on areas in cultivation but on which effective control measures can be established and still permit the growing of clean-tilled crops. (For field use this slope classification was divided into B and BB).

BB, 8-12 percent -- Slopes on which clean-tilled crops may be grown if more effective measures are used than on B slopes.

C, 12-20 percent -- Those slopes on which clean-tilled crops should not be grown but which may be used for legumes, pasture, and other close-growing crops, if planted to provide cover throughout the year.

D, over 20 percent -- Those slopes which are too steep to permit effective erosion control if in cultivation.

Table 5 shows the distribution of slope classes in the watershed and the degree of erosion occurring on each class of slope.

A study of the data reveals that the amount of moderate to severe erosion increases progressively through the slope range up to 20 percent, that on slopes of 12 to 20 percent the amount of severe and very severe erosion is comparatively greater than on other slope classes. The most severe erosion has occurred on C slopes, the average loss being 36.5 percent on these slopes. The average loss on BB slopes was 30.8 percent and on B slopes, 17.9 percent.

Table 5. Distribution of the slope classes in the degrees of erosion in the entire project as shown in the soil conservation survey report

Degree of erosion	Slope classes and limits									
	A 0-3 percent		B 3-8 percent		BB 8-12 percent		C 12-20 percent		D Over 20 percent	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
No apparent erosion	250	4.8	11	0.1	2	(1)	4	0.1	3	0.1
Recent alluvial and colluvial deposits	182	3.5	8	.1	0	0	0	0	0	0
Slight erosion	4,723	90.9	5,858	72.4	839	17.0	294	9.8	2,029	53.3
Moderate erosion	37	.7	2,016	24.9	2,472	50.2	1,671	55.6	1,647	43.3
Moderate to severe erosion	0	0	120	1.5	1,284	26.1	751	25.0	93	2.4
Severe erosion	3	.1	72	.9	270	5.5	220	7.3	32	.8
Very severe	0	0	10	.1	60	1.2	65	2.2	2	.1
Total	5,195	100.0	8,095	100.0	4,927	100.0	3,005	100.0	3,806	100.0

[1]Less than 0.1 percent.

Although the steepness of slope is of primary importance in classification other characteristics are of importance such as length, uniformity, direction and pattern. These additional characteristics must be considered in developing plans for erosion control and proper land use.

Cover or land use.

Another factor mapped was land use which shows a permanent record of vegetative cover for the year in which the survey was made. It shows the amount of cropland, idle land, pasture and timber land. Class F, woodland, includes land with 40 percent or more of the ground covered by shade of trees of any age. Areas with less than 40 percent crown density were not mapped as woodland. The pasture quality is determined in relation to average pasture conditions for the watershed. Cover areas were delineated in the same way as other factors. Symbols used in mapping land use and cover are shown in legend for conservation survey maps.

Data in table 6 indicates the distribution of land use and associated erosion onthe watershed.

Figure 10 shows a field on Leatherwood Creek project farm, near Heltonville. The soil is derived from impure limestone. The slope averages about 12 percent. The field was covered with excellent Kentucky bluegrass 25 years ago, according to a farmer operator. About 20 years ago the sod was turned under and the field was cropped to corn with severe gully erosion resulting.

Table 6. Distribution of land use classes in the degrees of erosion in the entire project as shown in the conservation survey report

Degree of erosion	Cropland		Idle land		Pasture		Woodland		Farmsteads and urban areas	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
No apparent erosion	3	(1)	1	(1)	24	0.4	242	4.3	0	0
Recent alluvial and colluvial deposits	81	.8	9	.5	73	1.2	27	.5	0	0
Slight erosion	5,376	54.5	704	37.0	2,996	48.0	3,556	63.2	1,111	80.0
Moderate erosion	2,861	29.0	547	28.8	2,526	40.4	1,645	29.3	264	19.0
Moderate to severe erosion	1,332	13.5	316	16.6	471	7.5	116	2.1	13	.9
Severe erosion	166	1.7	254	13.4	145	2.3	31	.5	1	.1
Very severe erosion	48	.5	71	3.7	13	.2	5	.1	0	0
Total	9,867	100.0	1,902	100.0	6,248	100.0	5,622	100.0	1,389	100.0

[1] Less than 0.1 percent.

Figure 10. A field on a Leatherwood Creek project farm, near Heltonville. Soil derived from impure limestone. Twelve percent slope. Very severe erosion has resulted from improper land use.

Economic and Social Factors Affecting Erosion

Of equal importance to the physical factors such as soil type, slope and erosion and related land use, considered of fundamental importance in planning a program of wise land use and essential erosion control practices, are the economic and human factors.

While the farmer is interested in conserving soil for future generations, at the same time he is in the farming business primarily to make a living for the present. Therefore, it was essential that a survey of the economic and human factors be made and the findings analyzed before attempting to develop a program for the area or for individual farms.

The survey from which economic and social factors were determined was made on 45 farms in the Leatherwood Creek watershed covering operations for the year 1935. They represented 19 percent of the watershed acreage and 16 percent of the number of farms, typical as to size, soils, topography and farming practices.

The information was needed to help determine the plan of work for the area; to fit the general plan to the needs of the individual farms; and to study the effects of the application of the plan, and to determine what changes, if any, were needed. The survey was summarized and analyzed by the farm management technicians of the Service and Purdue University staff from which much of the following data was obtained.

Number and size of farms.

During a period of 90 years there has been an increase of 58 percent in the number of farms in the project area. The trend has been toward smaller units, the major changes to farms of 160 acres. In 1846 the average size of farms in the project area of 25,028 acres was 171 acres as compared to the average of 106 acres in 1936.

Changes in size of farms were brought about by increased population and division of large holdings among heirs and removal of the timber resources. A gradual increase in the population of the area and surrounding communities is shown by the census reports, although a large percentage of the increase in the county occurred in towns, as industries developed.

Farm organization.

To show the differences in farm organization which made some farms pay better than others, data and tables used will contain averages for the 10 high income and the 10 low income farms as well as the average for the 45 surveyed.

Land use. In farm organization land use is a factor contributing to erosion. The 1935 farm business survey revealed that the average farm had about 40 percent of the farm in cropland, 52 percent in pasture, 4 percent in woodland and 4 percent in miscellaneous uses. Approximately 35 percent of the cropland was in corn, 25 percent in legume hay and a total of 5.4 percent of the cropland was being used for the production of close-growing crops, such as hays, grasses and small grains.

In comparing the crops grown on the 10 high and 10 low income farms, it would seem that the high groups were following a better cropping program, both for providing livestock feed and for erosion control. Although the high group was producing more corn, they were fall seeding more of the corn land to wheat, providing the land with winter protection. Less timothy and more legumes were grown by the high group. Eleven times as much alfalfa and three times as much clover and mixed hay was being grown. The low group had over two times as many acres of soybeans, which have been shown to be an erosion inducing crop. The greater soybean acreage seemed to be influenced by the soil type and natural productiveness of the soils. The 10 low income farms were practically all located on the impure limestone soils. More open permanent pasture was being provided on the high income farms, although the low income group had a larger total pasture acreage, because of a large percentage of woods pasture. Less protected woodland was found on the high income group, largely because the better soils were higher producing and the percentage of total woodland was less.

Pastures in the project area were of higher quality than for the county as a whole, as shown by the AAA appraisal of carrying capacity of 4.6 acres per animal unit in the county. The high 10 farms had more livestock, so it could be assumed their pastures were of higher quality, since they required fewer pasture acres per animal unit than the low 10.

Livestock enterprises. Livestock enterprises on farms surveyed in the area contribute to higher incomes and a better conservation program is indicated by the fact that the higher income farms were more heavily stocked, carrying twice as many cattle, hogs and poultry units as the lower income group. The average farm had 20 animal units of livestock.

The quality of stock on the area was of fair grade with some purebred herds. Seventy-six percent of the cash income on the 45 farms was from livestock, with more than one-third from dairy products, which were sold mainly as whole milk and cream, with those selling whole milk generally obtaining the greatest returns per cow.

Size and volume of business. The size and volume of business was one of the chief factors affecting income and certainly was a factor in determining how well the land was cared for. The outstanding difference between the high and low income groups was the gross income per acre and the gross income per $1,000 invested. The high and low groups had about the same number of crop acres per animal unit on the average. Since the high group had more livestock per 100 acre farm, they apparently have made a better use of the cropland, had higher crop yields, had more productive pastures and purchased more feed than the average in the low group.

A small number of farms were highly specialized, retailing home produced dairy and poultry products in Bedford. The sources of miscellaneous receipts were chiefly labor and AAA benefit payments. Only a small amount of crops were being sold from the farm.

The average labor income on the 10 high income farms was $1195, the 10 low income averaged $76, the 45 averaged $548. The farms of lower income, lower productivity and yields were usually associated with soils derived from impure limestone and sandstone. Yields from crops on the 10 high income farms averaged more per acre on all crops than the low group. See table 7.

Cropping systems. In the area as a whole the need of a better fertility and cropping program was becoming apparent. Due to frequent clover failures in recent years the rotations were indefinite, although generally a 3-year rotation was planned. Many of the poorer pastures were old crop fields thrown out of cultivation without much consideration given to establishment of a desirable type of vegetation.

In the attempt to produce grain needed on the average farm, land which was not adapted for grain production, as indicated by relatively low corn yields, was used for grain production. This resulted in a deficit of high quality roughage, and consequent high feed production costs. By using some of this land for legume roughage and substitution of this type of feed for some grain in the ration it became possible to follow a better land use program. Experience in the area has indicated that high quality roughage can be substituted for a part of the grain, on most farms, without sacrificing efficiency in production. In spite of this practice considerable grain had to be purchased on the farms. Some hay was also purchased. The survey data showed that more grain and less roughage was being fed on the average farm than necessary for most economical production.

Table 7. Yields of crops on high, low and average income groups.

Crop	High 10	Low 10	Average 45
Alfalfa (tons)	2.6	2.0	2.3
Clover or mixed (tons)	1.3	1.0	1.3
Timothy (tons)	1.0	0.9	0.9
Soybeans (tons)	2.1	1.5	1.7
Corn (bushels)	37.9	20.7	33.1
Silage (tons)	9.2	4.6	8.5
Oats (bushels)	25.5	7.4	20.0
Wheat (bushels)	18.6	8.8	15.2
Rye (bushels)	11.2	9.3	11.0
Pasture (acres per animal unit)	1.3	2.8	2.5

The number of livestock kept and the amount of feed fed on the farm has a direct correlation with the fertility program followed on the farm.

High income farms practices a better fertility program in that they had a higher percentage of cropland in legumes. Since they had more livestock they also had more manure to apply on the farm.

The low income farms purchased as much fertilizer per crop acre as did the high income farms but did not get the same yields because of different soil types and general differences in the farm program.

Land tenure.

Land tenure becomes a factor contributing to erosion because of the insecurity of the average tenant and the fact that two parties become interested in an income from the land. The economic survey showed that 40 percent of the project farms were tenant operated, chiefly on the crop and livestock share system. The annual shift in tenants was not heavy in the watershed, although few leases were for longer than 1 year. Tenant operated farms are sometimes better cared for than owner operated, under favorable lease conditions.

Living conditions.

There is a direct correlation, barring outside influences, between the level of living conditions and the inherent productivity of the land. The farmers in the upper end of the area located on poorer soils could not enjoy the conveniences and comforts that were the privileges of those on better land. This is indicated by the spread in labor income between the high-10 and low-10 income farms. Certainly the low income group with an average labor income of $75 per farm, could not live as comfortably as the higher group with an average labor income of $1,248. However, the project area as a whole was maintaining a higher level of living conditions than the county as a whole.

The area is well served with telephone and electrical facilities. Schools in the area are better than in the county as a whole. Heltonville and Shawswick consolidated schools furnish educational facilities for the rural youth. In addition, some rural students attend the Bedford city schools. Several of the younger farmers in the area are high school graduates and a few are college graduates.

The system of roads in the project area is very good, none of the roads being impassable during the winter. There are about 8 miles of concrete highway running through the area, as well as about 20 miles of black-top highway. The remainder of the roads are of good gravel or stone construction.

The per farm average machinery inventory was low. Due to economic pressure the farmers had purchased little new equipment or made any appreciable improvements on buildings.

The let-up of stone work due to general economic conditions caused many stone workers to move to the farm. Some purchased farms and others rented land. Many small houses and cabins were built in the area, the primary consideration being to have cheaper shelter and produce food for home use. This factor of unemployment had its effects on the outlet of farm produced goods, particularly affecting farmers living near Bedford.

Erosion Problems

Soil losses.

The major problems resulting from erosion in the watershed were caused by sheet erosion. The class of erosion predominant on B slopes was 2 and 3, on BB slopes, 3 and 33, on C slope the erosion was usually 3 or 33. The most serious cases of sheet erosion were found on the steep slopes which had been in cultivated row crops. Fields are regular in shape and cultivation has usually been parallel with the fences regardless of the slope.

Rotations in use on the area consisted too often of clean-tilled crops with insufficient legumes and grass included. Many fields were left without cover crops during the winter and spring months. This frequently results from the lack of the use of lime and fertilizer necessary to establish meadows.

Pastures have been neglected in the area. Uncontrolled grazing, lack of lime and fertilizer, and mowing have resulted in thin and undesirable vegetation which is not effective in holding soil and moisture.

Woodlands have been used too much for timber harvest and grazing. Farmers have overlooked the fact that woods so used defeat either purpose, since livestock grazing in woods prevents reproduction and destroys leaf litter which is essential to vigor and growth of trees.

Cultivation of steep slopes, without erosion control practices; cultivation of land so eroded as to be unprofitable for crops; idle land which could be used for desirable species of grasses, legumes or trees, are examples of land misuse.

Farmers cite numerous cases where rocks which are now exposed because of erosion were once covered with soil. Highway workers have had to remove from roadside ditches and pavements tons of the soil which washed from adjacent fields. Figure 11 shows the deposition of soil from the cultivated slope above as the result of an intense rain. Most of the corn in the foreground is covered with silt. The roadside ditch adjacent to the field was filled with 14 inches of soil.

Water losses.

There is a small amount of damage in the lower part of the watershed due to creek overflow, and backwater from the White River. Due to the steepness of the Leatherwood Creek channel, the water will rise and recede quickly. That the water carries considerable silt is evident from the muddy color. When White River is at flood, crops are sometimes drowned or covered with silt in the lower part of the watershed.

Figure 11. Deposition of soil eroded from cultivated slope above. Most of corn in foreground covered. Road ditch adjacent to field filled 14 inches with silt.

An apparent correlation of rapid run-off and soil removal is a decrease in ground water supply. Farmers cite instances where springs which formerly flowed continuously are now wet weather springs. Silt in some cases has raised the surrounding surface so that water ceases to flow until the deposit is removed. In other cases the ground water storage supply has apparently been exhausted. Ponds and wells are uncertain sources of stock water in the area on account of the rock strata near the surface which may develop seepage.

Available Applicable Erosion Control Information

Remedial measures, applicable to soil and moisture conservation in this area, justifiable in the light of physical, economic and social conditions were based on information pertaining to methods of prevention of soil and water loss by erosion. The information was obtained from such sources as erosion experiment stations, agricultural experiment stations, other projects of a similar nature and common sense practices which have been in successful use by farmers here and elsewhere.

Results obtained by experiment stations check closely despite the fact that they may be obtained under differing conditions.

The Agricultural Experiment Station of the University of Missouri pioneered in studies relative to the effects of different cropping systems and methods of culture on erosion and water loss.

The annual losses of plant nutrients in the eroded soil from continuous corn or wheat during a 2-year period were shown to be as great or greater than plant nutrients used by the crops (5). Results similar to this have been obtained by erosion experiments located at Bethany, Missouri; Clarinda, Iowa; Hays, Kansas, LaCrosse, Wisconsin; Guthrie, Oklahoma, and Zanesville, Ohio. These experiments have produced data which are unquestionable proof of the relation between land use, tillage practices, soils, slopes and erosion.

The production and management of pastures as a means of erosion control is set forth in Ohio Agricultural Extension Bulletin 154, by D. R. Dodd and R. M. Salter. The principles of rotation in their relation to the maintenance of soil productivity and to soil improvement were shown in U.S.D.A. Farmers' Bulletin 1475.

The effect of fertilizers on Indiana soils and crops, by Wiancko, Scarseth and Walker (9) presented recommendations on the selection and use of fertilizers for different crops under soil conditions similar to this area.

Other watershed erosion control projects in which the personnel were engaged in working with farmers on a coordinated erosion control program were located in Michigan, Ohio and Kentucky. While these projects were new, methods of erosion control in each were similar but data on results were meager in the beginning of the programs.

Eleven Soil Conservation Service CCC camps had been in operation in Indiana long enough to have established conservation practices on numerous farms as demonstrations, to guide the development of and extension of new methods.

While adequate to justify recommendations by the Service adjustments in use and treatments of the land in the watershed, based on information obtained by research and experiment were further supported by practices in use by farmers in and near the area.

One of the most frequently observed measures was the use of trees and shrubs in draws and on steep slopes. This sort of natural protection served to demonstrate the practicability of the use of trees and shrubs of desirable species.

Sod as an effective erosion control agent was found in pastures, and in an occasional waterway.

Contour tillage, which occurred in a few instances as a result of topography fitting the practice, was used to show the effectiveness of the practice and the adaptation of the method to the topography.

The practice of strip cropping was in use on one farm in the watershed when the Service came into the area. This particular field had been contour strip cropped for the past 20 years. Borings made in this field showed an average of 5 to 6 inches of topsoil was present while in an adjacent field which had not been contour farmed the topsoil depth varied from 1 to 5 inches. Soil moisture tests on the two fields showed there was more moisture in the soil on the strip cropped field.

Gully control through the use of vegetation, stone and brush was practiced in a haphazard way by most farmers. The success and failure of methods were evident on observation of results where gully control work had been done.

Available Facilities

Intelligent action can begin only after careful planning. Controlling erosion cannot be confined exclusively to land use adjustments and the installation of erosion control practices. We must recognize the fact that we are dealing with a group of interrelated factors and problems.

A list of the facilities available in this area for use in effecting an erosion control program brought out an array of agencies engaged in tasks related to that of the Soil Conservation Service.

Eleven CCC camps were working on the erosion control job in Indiana. One of the camps was located at Bedford. These camps were assigned to the Bedford project office for administration and supervision.

Lawrence County was alloted money for W.P.A. projects and approximately 250 men were made available for use in constructive phases of soil conservation work on the watershed.

An organization had been set up for administering the program of A.A.A. which was assembling information pertinent to production control, land use and soil conservation.

A state law had provided for the State Planning Board and County Planning Commission whose duties included development of a program of land classification and use. County surveys were planned to determine sources of income, natural resources, topography, erosion, waste and submarginal land, forestry possibilities and industrial development.

The Lawrence County Farm Bureau, cooperating with the Extension Service, was interested in soil conservation. Extension Service personnel cooperated with the Soil Conservation Service personnel in locating the project in Lawrence County, in determining the over-all plan of operations, and in the development of the demonstrational work. A State Soil Conservation Extension Agent was selected to develop this activity in the state.

The Hoosier National Forest project engaged in the purchase of land in the county for inclusion in the forest unit. The Lawrence County National Farm Loan Association provided funds through the Federal Land Bank for farming purposes. The Rural Rehabilitation Administration made loans to parties wishing to start farming but who were unable to do so without financial assistance. The State Department of Conservation, with local clubs, interested in reforestation, park improvement and in the conservation of wildlife, were other agencies engaged in conservation programs.

A Memorandum of Understanding between the Soil Conservation Service and Extension Service and between Soil Conservation Service and State Experiment Station was effected.

Two local daily papers offered a medium for disseminating information on SCS work. The Kiwanis Club afforded an opportunity for business and professional men to learn of and assist in developing the program. Through the office of the state coordinator these agencies were able to unite in an effort towards the wise use of land resources.

THE SERVICE WORKS WITH THE FARMERS

In preceding pages there have been indicated separately many factors which have contributed to soil and water losses in the Leatherwood Creek watershed area. Inventory of physical, economic and social resources, as any business inventory, does not express opinion, offer advice or make plans so much as assemble data required for formulation of adequate plans.

The next step involves the use of the information in forming an over-all plan of land use and adaptable erosion control measures for the project, suitable to conditions existing in the area and adequate to conservation of soil and water.

Basic Land Use Classification

Table 8 presents a simple land use classification based on the physical factors as found by the conservation survey. The land use classes shown in the table were developed to conform to the needs of soil, slopes and degree of erosion.

Table 8. Classes of land according to planned use based on soil type, slope and erosion

Soil types	Cropland		Meadow		Pasture		Woodland	
	Slope	Erosion	Slope	Erosion	Slope	Erosion	Slope	Erosion
Guthrie Lawrence Tilsit Bottom land	A	1,2	0	0	0	0	0	0
Lawrence Bedford Hagerstown Dunmore Tilsit	B	2	0	0	0	0	0	0
Bedford Hagerstown Dunmore Tilsit	B BB	3,33 2,3,33	B C	37,38,338 2,3,33	B BB	37,38,338 37,38 2,3,33,37 38	BB C	338,339 37,38,338,339
Hagerstown Dunmore Tilsit Muskingum	0	0	0	0	0	0	D D	All erosion

Erosion Control Practices

Following are the basic recommendations for erosion control as developed for application to the various land uses.

Cropland.

Rotations. Two and three-year rotations of corn, wheat, sweet clover or meadow recommended for bottom land where erosion is not a problem and where soil is deep, well-drained, fertile. For less fertile and more rolling cropland, a 4-, 5-, or 6-year rotation. Meadow of timothy and clover on sweet fertile soil or redtop and Korean lespedeza if soil poor and acid. Tilled crops not to follow in succession or occur more than once in rotation.

Contour tillage. Recommended on B slopes with 2 erosion. (See table 8.)

Terracing. Recommended on long slopes of 3 to 10 percent, where soils sufficiently deep.

Field stripping. Straight, parallel strips not to exceed 126 feet in width, across the general slope on gently and fairly regular, low B slopes.

Contour strip cropping. Recommended on B and BB slopes with 2, 3 and 33 erosion. Consists of a strip of close-growing crops on either side of a cultivated strip; width to vary from 70 feet on BB slope to 100 feet on B slopes.

<u>Buffer strips</u>. Recommended where strip cropping not possible or practical, or until strip cropping could be established.

<u>Diversion ditches</u>. Used to prevent water concentration on problem slopes, and to intercept run-off that causes flooding and silting of bottom lands. Will conform in general to terrace design, and discharge into vegetative or structurally controlled outlets.

<u>Sod waterways</u>. To be established in draws and other places where water concentrates.

<u>Conversion to vegetation</u>. Recommended for cropland on B slopes with 38 and 338 erosion, on BB slopes with 37, 38 and 338 erosion, on most C slopes with 2, 3, 33, 37 and 38 erosion. Pasture, meadow and waterway vegetation recommended consisted of Kentucky bluegrass, redtop, white clover, timothy, orchard grass and Korean lespedeza.

<u>Conversion to trees and shrubs</u>. Recommended for gullies cropland on B slopes, BB slopes with 9 erosion, steep C slopes with 2, 3 and 33 erosion and all C slopes with 37 to 9 erosion and all D slopes.

<u>Good farming practices</u>. The application of lime as needed, use of adapted legumes and grasses for hay, rotation pasture and green manure; feeding of crops grown on the farm, including wheat; application of manure to wheat and meadows, and application of fertilizer to wheat and corn.

Pasture and meadow land.

No physical control measures recommended for pasture and meadows on A slopes. Treatment recommended on most pasture and meadow land due to acidity, low fertility and over-grazing. Treatment to consist of lime, fertilizer and reseeding.

Contour furrows. Recommended on C slopes with 2 erosion. Consisted of one or two level plow furrows turned downhill, ends to be turned up and furrows blocked every 20 to 25 feet, the depth to be 5 to 10 inches. To be laid on contour and constructed with breaking plow. Disturbed area to be limed, fertilized and reseeded to suitable vegetation.

Conversion to trees and shrubs. Recommended on all B slopes with 38 and 338 erosion, BB slope with 37, 38, 338 and 9 erosion, on most C slopes and all D slopes.

Idle land.

Areas adjacent to woodland were to be fenced with the woods and planted to suitable trees. Areas surrounded by cropland were to be returned to shrubs, trees or grass.

Woodland.

Planting. Recommended on sheet and gully erosion, the species determined by adaptability to location and farmer's needs.

Management. Management recommended consisted of simple, practical system of selection cutting, suited to farm needs and soil and moisture conservation.

Protection from grazing. Recommended for all woodlands by a properly constructed fence to allow for reproduction.

Protection from fire. By education of landowners in regard to the damage caused by fire; by working tops, limbs and dead material, salvaging usable wood and reducing brush to small size and scattering over the ground.

Control of insects of diseases. By good silvicultural practice and management by cleaning up diseased and dead trees.

Wildlife areas.

Recommended a survey of the wildlife resources be made, and an education program as to importance and use of wildlife be developed, new habitats created by retirement of waste areas, gullies fenced in and planted and pond banks planted to desirable species. Fence rows and roadsides regarded as areas of potential wildlife value. A border 25 to 100 feet wide for woods adjacent to open fields to be left. Clumps of briers, dogwood and coralberry to be encouraged to serve as adequate cover in areas where trees were to be planted.

Gully control recommendations.

Permanent structures. (Generally rock masonry or reinforced concrete.) Where growing conditions and/or run-off velocities prevent successful use of vegetative control.

Temporary structures. Consisting of brush, or log dams and litter fills, fastened mulching, brush waddles, vegetated flumes from materials available on farms.

Vegetation. Consisting of already growing vines and grasses that will cover eroded portions in shortest possible time. (Where vegetative litter is used on gullied sections, grasses will cover the ground more quickly, due to organic matter and fertility resulting from decomposition of such litter.) Redtop and Korean lespedeza on gullied areas. Trials to be made with Kudzu and wild honeysuckle. Grasses sowed at most desirable season and seeded under thinly placed litter without disturbing the soil.

Bank sloping. Varying in extent within a wide range of treatment. Shallow gullies plowed in and planted. On other gully banks only a small amount of sloping to fill or partially fill the dam basins with topsoil. Gully slopes to be planted solid, sloped to $1\frac{1}{2}$:1. Only in exceptional cases should steep gully banks 8 feet or more in height be completely sloped for solid planting. For some gullies, planting trees and grasses, without sloping banks or building temporary or permanent structures.

Plantings. Fenced against any kind of livestock which would interfere with establishment and growth. Black locust seedlings will be planted on gully slopes. Plantings supplemented with mulch and seeded to lespedeza and redtop, and possibly rye-grass. The seedlings of tree species a spacing of 2 to 3 feet. Before any planting, gully banks sloped when necessary and left rough in order to make soil as stable as possible, thus enabling grasses to catch. In addition to the grading, mulching with manure. Staking brush down will bring about a more effective check on erosion.

Data on land use capability classifications with recommended treatment and erosion control measures, as determined in actual practice are shown in tables in the appendix.

Selling the Program

Education.

The Soil Conservation Service endeavored to present the information on all questions involved in the conservation program, so that the public in general, farmers and the technicians themselves would have a full and clear understanding of the principles underlying the agreements which would finally be reached and written into a workable solution of the problems.

One of the first channels used in getting the program started was through the local county agent's office. Available farmers in the area who had been leaders in advancing the lines of agricultural progress were a nucleus around which the program could grow. Requests for work were routed through the county agent's office. A series of meetings was held in schools in the area. Project technicians talked, exhibits and slides were shown, of the methods used by the Service, whenever groups of farmers and business men could be assembled.

Two local newspapers accepted news releases once each week. Both papers reached rural subscribers.

A tour was planned by the county agent in the spring of 1936. A representative of the Prairie Farmer magazine was present and later published an article concerning the Bedford project. The attendance on this tour was about 150.

The project manager formed a committee of eight leading farmers in the project area. This committee frequently met in the Soil Conservation Service office for consultation and to advise with the staff pertaining to program development. The members of this committee were helpful in creating interest in their respective neighborhoods.

Technicians were engaged at all times in carrying the program to individual farmers. An effort was made to call on all land occupiers and arouse their interest in conserving their lands. There was much misunderstanding at the beginning among the farmers concerning the work. Some believed that signing an agreement meant losing control of their farm or that farm operations would be dictated. Others objected to signing any papers. Some assumed the attitude they could do as well as experts in erosion control. Some argued erosion was not active on their farms. Some believed conservation practices were not practical or economical. Some expressed opposition on political grounds.

The agreement.

Three types of agreements were made to start action in the area. Due to the pressure of employing 260 W.P.A. laborers at the earliest possible moment, on jobs involved in the program, a temporary 5-year agreement was made with some landowners, for doing specific work on their farms. Gully control, woods improvement and fencing were among the principal kinds of work done with W.P.A. labor at the outset. Later, it was hoped, a complete conservation plan would be developed for these farms.

On certain farms desirable locations were found for quarrying and pulverizing limestone for agricultural purposes. Agreements were made with four landowners distributed throughout the area, allowing the government the use of these quarry sites. The government provided access to the quarry, labor and machinery for quarrying and crushing. These agreements were made for 1 year with option for renewal. Limestone was used on cooperators' farms in starting the demonstrations.

The third type of agreement was used to incorporate the terms under which the Soil Conservation Service planned a complete program of soil and water conservation on a farm as a demonstration to others of ways and means which were practical and applicable.

Fundamentally the contents of the agreement have remained the same. Incorporated in the agreement are statements of the legal factors, statements of the contributions in equipment, labor or material to be furnished by the government and cooperating parties; a plan for land uses, erosion control practices, cropping practices and soil amendments. Maps were made showing the soils, slopes, erosion and land use before agreement and land use afterwards, with significant symbols. A work sheet was prepared showing the past, planned and anticipated economic balance of the program. From time to time amendments were made in writing and attached to the original agreements whenever changes could be made to improve the original plans.

Farm planning technique.

When a prospective cooperator was located a visit was made to the farm and a brief explanation of the program given. This visit was for the purpose of making a definite appointment.

On the second visit the general aspects of the program were discussed and the major control measures which might be used were described and explained. Actual photographs illustrating the different measures involved were used.

The farm was then gone over by the technician, accompanied by the owner or owner and tenant. Soils and erosion on the various fields were observed and discussed and the future land use for these fields or different portions of the fields was indicated by the farmer. As many suggestions as possible were obtained from the farmer, with his reasons for his planned land use. Rotations were also discussed as well as his various farm problems. An attempt was made to get the farmers to suggest their problems and indicate what control measures might be the solution.

An idea of his ability and willingness to purchase necessary soil amendments, fencing, posts and other materials was arrived at and taken into consideration in working out the plan. The technician, with the farmer's ideas of land use, rotations and control measures and problems and the necessity for certain land uses in mind, tried to work out a good coordinated, workable farm plan which would suit the farmer and comply with Soil Conservation Service policies and give reasonable possibilities of a good demonstration.

If while formulating the program any special problems presented themselves on which the planning technician felt as though he needed help, project staff specialists were asked to assist in laying out fence lines, marking timber to be used for fence posts, indicating pond sites, gullies for gully control work, terrace fields and outlet sites. These technicians were introduced to the farmer and plans made with him as to the time his team and man labor, fence and other such material should be available.

Representative Farm Plans

The methods employed in detailed farm planning on this project will be shown by a description of five farms, three representing a cross-section of pure limestone area and two farms representative of the impure limestone and sandstone soils in the upper end of the watershed.

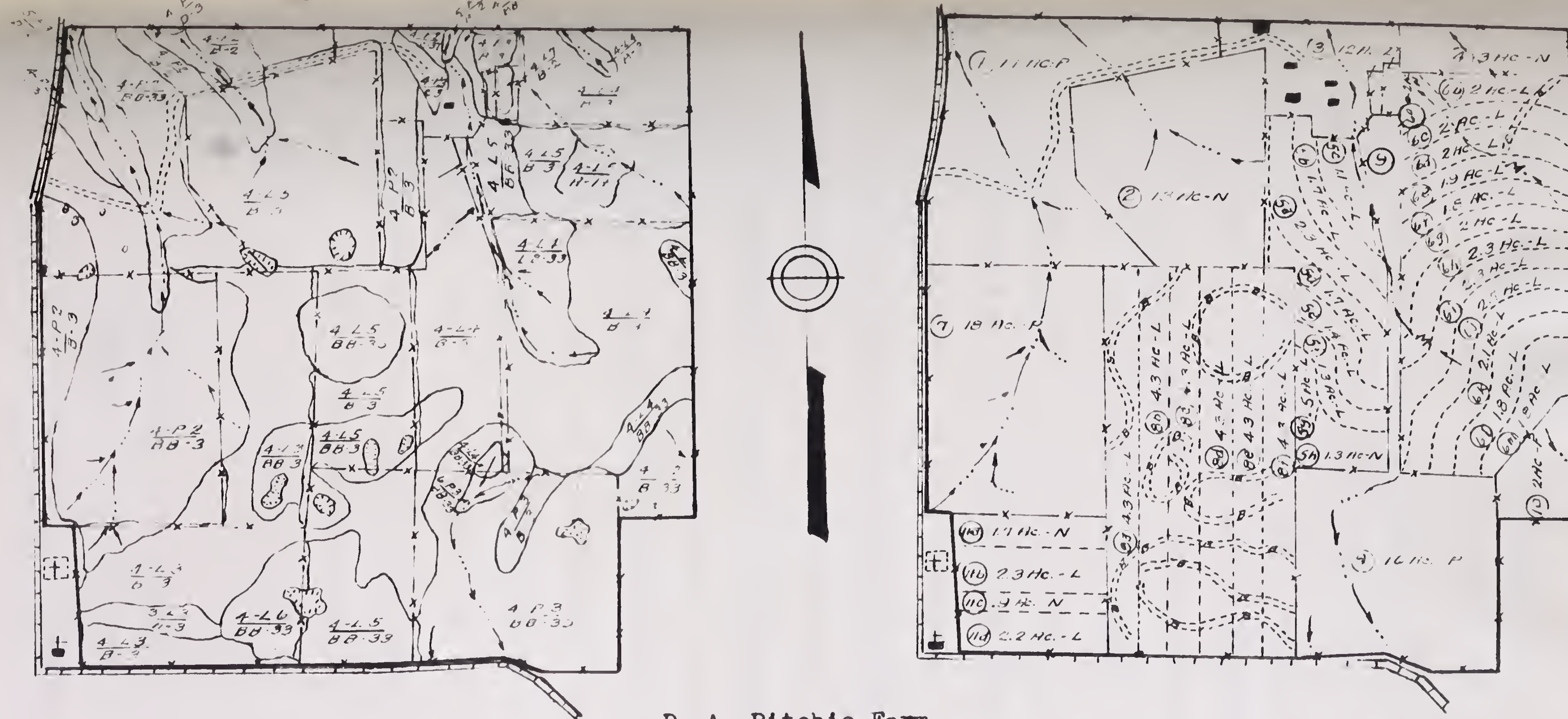
Explanation of land use and erosion control practices which were used on these farms is given as an example of work which may be done on any farm under comparable circumstances.

A dairy farm.

The first farm to be described is a 151-acre tract operated by D. A. Ritchie, 7 miles east of Bedford. The main source of income is from the sale of dairy products. The owner-operator purchased the farm 20 years ago, coming from northern Illinois with his wife and three children. The children were in grade school, two boys being large enough to help on the farm. Ritchie had been accustomed to following a corn-oats rotation and began this type of rotation on his hill farm. He grew some wheat as a cash crop, and some sweet clover and sapling clover for hay and green manure.

The survey. Fields 7 and 9 (fig. 12B) had been cleared of timber just previous to 1920 and had been planted to corn almost continuously until 1933. Since that time they have not been plowed and pasture vegetation has come in. Under the type of rotation followed an abundance of grain was being produced, often some corn being sold, but there was always a shortage of hay, which had to be offset by purchase. The operator believed he could buy hay cheaper than he could produce it.

12 A 12B



D. A. Ritchie Farm
151 acres

Figure 12 A. Conservation survey map showing soil, land cover, slopes and erosion areas, before planning.

12 B. Land use map after planning, showing strips on cropland, land use, etc., after planning. See symbol legend page 182.

He had the only purebred Guernsey dairy herd in the area and kept purebred Poland China sows. He kept on an average eight head of horses, a Percheron stallion and raised colts for sale. Dairy cows were fed oats straw, soybean hay, silage and grain. When hay was high in price he fed a lower quality roughage. Due to poor feeding practices the cows had been losing their calves and the heifers were under-developed. On the average only about one-fourth of the corn ground was covered over winter, about one-half of the corn land was seeded to oats in the spring, and about one-fourth was planted back to corn. Oats and corn were used on the farm and most of the wheat was sold as a cash crop. Only about half enough hay was being produced on the farm (including silage as hay equivalent). The deficiency had to be made up by purchase. Non-legume hay was the principal roughage. Insufficient rotation meadow was available for supplementary grazing. The operator was renting pasture in mid-summer for young cattle and dry cows. He needed approximately 1,000 bushels of grain for his stock and was producing 1,500 bushels. He needed 65 tons of hay and produced about 35 tons. He needed pasture for 34 animal units and had pasture for about 22.

Practically all the soil on this farm is Hagerstown silt loam. A large percentage of the cropland acreage falls into the B slope class with most of the remainder in the BB slope class. Three-fourths of the pasture land has BB slope. About 80 percent of the cropland has 3 erosion and the remainder 33 erosion. Although the slopes are not steep on this farm the degree of erosion indicates that some land use changes and erosion control practices are necessary.

The distribution of soils, slopes and erosion in relation to land use on this farm before planning is shown in table 9B.

The operator had made a practice of using 125-150 pounds of fertilizer per acre on corn and wheat, but no lime was used before 1936. Frequent clover failures in recent years had resulted in a large proportion of the acreage being planted to clean-cultivated crops, causing increased erosion and decreased fertility.

In going over the farm with the cooperator we found that the operator was conscious of sheet erosion, and that something was causing frequent clover failures and decreased yields of grain crops. He was putting all the manure from a large dairy herd on his corn ground, and top dressing for wheat. He was fertilizing corn and wheat with average applications of a recommended fertilizer. The farmer knew something was wrong and welcomed a solution or partial solution by the Service. Soil tests showed that the first requisite was limestone. The cropland needed 2 tons per acre and the meadow land 3 tons per acre to grow alfalfa or sweet clover. The humus content of the soil was low, due to meadow failures and over-grazing of the present vegetation.

Table 9A. Land use and practices after agreement in relation to soil type, slope and erosion

Land use	Soil type 4	Slope					Erosion				Practices			
		A	B	BB	C	D	1	2	3	33	Ct	CS	Pt	FS
Cropland-ac.	63.2	2.4	45.4	20.4			1.4		53.6	13.2	32.5	32.5		35.7
Meadow -ac.	19.1		16.1	3.0					18.0	1.1				
Pasture -ac.	51.2		10.0	37.5	.6	3.1		2.1	40.4	8.7			25.0	
Woodland-ac.	2.3		2.3							2.3				
Totals	140.8	2.4	73.8	60.9	.6	3.1	1.4	2.1	112.0	25.3	32.5	32.5	25.0	35.7

Ct - Contour tillage
CS - Contour strip cropping
Pt - Pasture treatment
FS - Field stripping

Table 9B. Land use before agreement in relation to soil type, slope and erosion on Ritchie farm

Land use	Soil type 4	Slope classes					Erosion classes			
		A	B	BB	C	D	1	2	3	33
Cropland-ac.	86.3	2.4	59.1	24.8			1.4		69.2	15.7
Pasture -ac.	52.2		12.4	36.1	.6	3.1		2.1	42.8	7.3
Forest -ac.	2.3		2.3							2.3
Totals	140.8	2.4	73.8	60.9	.6	3.1	1.4	2.1	112.0	25.3

The agreement. The cooperative agreement was signed April 1936. Some of the contour strip cropping was installed in planting the 1936 crops. In getting the demonstration under way as quickly as possible, the Service furnished 30 tons of agricultural limestone to be used on cropland, 36 tons for 16 acres of alfalfa meadow and 8 tons for 4.5 acres of pasture treatment. In addition, the Service furnished 900 pounds of fertilizer for 3 acres of alfalfa meadow. The Servicefurnished 30 pounds of alfalfa seed and 6 pounds timothy to establish 3 acres of alfalfa meadow. The cooperator furnished fertilizer and seed to establish 13 acres of alfalfa. He agreed to spread all the limestone in the spring and summer of 1936 on the crop, meadow and pasture land. W.P.A. labor employed by the Service built or re-arranged woven wire fence to protect woodland and meadow, and to facilitate the use of pasture land. Some gully control work was also done by W.P.A. labor.

After a thorough discussion of the economic and erosion factors involved in growing corn for feed on this hill land, Mr. Ritchie agreed to reduce his corn acreage and try some good legume hay such as alfalfa. The next question that arose was the need for control measures on the cropland. He agreed to try 13 acres of contour strip cropping and farm the remainder of the cropland by using field strips.

Because of the need for hay for 41 animal units of livestock it was agreed that some of the more difficult areas of the cropland be retired to a permanent meadow, mainly alfalfa. Sixteen acres (fields 2 and 4) were set aside for alfalfa-grass production.

The remaining cropland was set-up on a 3-year rotation of corn, wheat and grass-legume meadow, which would allow about 23 acres of corn per year, instead of 45 acres formerly grown. This was as great a reduction in corn acreage as the operator was willing to sacrifice at the beginning.

After the cropland changes had been agreed on, the problem of how to get more pasture was still to be solved. Since the acreage could not be reasonably increased, a program of treatment was planned. Four and five-tenths acres of permanent pasture were to be limed and fertilized and plans made for rotation pasturage to relieve the permanent pastures during dry summer months.

This farm had only 2 acres of timber remaining. Mr. Ritchie agreed to keep it fenced from livestock. There were numerous sinkholes and draws throughout the farm which were to remain as potential wildlife habitats.

Due to the decrease of grain grown, hogs were to be reduced from six units to four units, horses were to be increased two units and the number of cattle kept about the same. The planned crop program seemed to fit in well with the planned livestock program and the cooperator was satisfied.

Thirty acres of corn, planted in 1936, made an average yield of 30 bushels per acre, 15 acres of wheat averaged 16 bushels per acre, 25 acres of spring seeded red clover drouth killed during the summer and 15 acres of oats made 1 ton of hay per acre. After observation of the effects of the program and discussion with the farm planner, the operator agreed to try a 4-year rotation. This lengthened rotation would add more organic matter, furnish more hay and keep the ground covered more of the time. Planting fewer acres of corn and using a heavier fertilization would perhaps yield as much total grain in the long run. Failure of 25 acres of clover presented a good opportunity to make rotation and land use changes. The AAA allotment for 1937 did not permit complete adjustment, but in the 1938 crop plan the adjustment to a 4-year rotation was made. In the spring of 1937 the operator limed 18 acres more cropland and 14 acres of pasture. The lime was furnished by the Service in an agreement whereby the cooperator furnished 2 tons of 20 percent super-phosphate for pasture treatment. Nine acres of pasture in field 9 and 5 acres in field 1 received 1 ton of lime per acre and approximately 300 pounds of 0-20-0 fertilizer per acre in April 1937. In field 9 the cooperator also manured about 7 acres in addition to what was fertilized.

Field 4, a 3-acre field converted to alfalfa, had to be reseeded in the spring of 1937. The Service furnished the alfalfa and timothy seed and the cooperator furnished the fertilizer. The alfalfa in field 2, which looked in the spring of 1937 as if it might be crowded out by the wheat and timothy, was pastured with 15 head of dairy cows during April 1937. The cattle grazed the wheat and timothy down and the alfalfa came out in good shape. The wheat grew up again and made a good yield.

By the fall of 1937 the cooperator was willing to make additional improvement in his program. He was more favorable towards the use of contour strip cropping after trying it for 2 years. In the spring of 1938 fields 5 and 6 were re-laid. Eighty-four and ninety-eight foot contour strips were installed in both fields; the layout that exists at the end of the 5-year period covered by the agreement. To prevent making too drastic a change in the layout in field 6, two 20-foot contour sod buffer strips were included in the strip crop system. Thus by gradual change, Mr. Ritchie now farms all his cropland under a strip cropping system. In the spring of 1938 he limed about 14 acres more cropland at the rate of 2 tons per acre and in the spring of 1939 limed 10 more acres of pasture at the same rate. In addition, he disced and seeded field 9, 16 acres, in the spring of 1939 with the following per acre seed mixture: 2 pounds alsike clover, 3 pounds lespedeza, 2 pounds red clover, 1.5 pounds alfalfa, 3 pounds timothy and 1 pound of redtop. The timothy and redtop were seeded in the fall of 1938.

Controlled grazing has been practiced on all pastures since agreement.

<u>Tangible results</u>. Since 1937 the cooperator has converted about 3.5 acres additional cropland to alfalfa. These areas are critical portions of the crop fields that are difficult to farm and have been eroding under cultivation. In Figure 12B, these areas are shown as 5h, 6a and 11a.

Sixty-one percent of the B slope and thirty-three percent of the BB slope is to remain in cultivation, all to be protected by erosion control practices. Thirty-two and five-tenths acres are being farmed under an 84-foot strip crop system and the remaining cropland is being farmed under a field strip system using buffer strips at sharp breaks adjacent to sinkholes and short steep slopes. About one-half of the 3 and 33 erosion acreages will remain in cultivation due to the need of the acreage for a balanced cropping system and the adaptability of control measures on the cropland. The pasture acreage has not materially changed, but 25 acres to date have received treatment with lime and fertilizer and more will be done on remaining permanent pasture.

In 1939 Mr. Ritchie's pasture production records showed that 4.3 acres untreated pasture were necessary to carry one animal unit through the grazing season; 3.3 acres necessary after treatment with lime and fertilizer; 1.8 acres necessary after treatment with lime, fertilizer and reseeding.

Since 1936 all of Mr. Ritchie's cropland has been kept covered over winter. The corn has been put in the silo or shocked so that wheat could be seeded. The 1939 seeding on the rotation land was a 2-1-10-1-2 seeding of lespedeza, red clover, alfalfa, alsike and timothy. This type of seeding shows more promise of a stand suitable to hold soil than any previous mixture that has been used.

Because 25 acres of clover seeded in the spring of 1936 failed, the average hay yield for 1936 was extremely low. This clover failure also accounts for the large acreage of wheat in 1937. Although the 1939 corn yield is not as great as the year's previous, it is still much better than the 1936 yield.

Table 10 shows the acreage and yield of crops on the farm for the past 4 years, as taken from Mr. Ritchie's records.

Under the planned program 34 acres of rotation cropland may be used for supplementary pasture each year, in addition to a 13-acre alfalfa meadow. The treatment program on the permanent pastures will easily permit the carrying of 25 animal units. The anticipated production of 116 tons of hay includes 80 tons of silage as hay equivalent.

The amount and cost of digestible nutrients produced before the program was planned contrasted with the amount and the cost of producing 1,000 pounds of digestible nutrients after planning shows an increase of 33,896 pounds of digestible nutrients is expected each year during the 3-year period of 1938-40, as compared to each year of the 3-year period 1933-35, at a 38 percent lower unit cost. The lower unit cost is expected largely through increased hay and pasture and decreased corn and oats production (6). A comparison of planned production of feed, with actual production in 1939 indicates that the program is giving expected results from an economic as well as an erosion control angle.

Table 10. Acreage and annual yield of important crops. Ritchie farm

	1936		1937		1938		1939	
	Acres	Yield/Ac.	Acres	Yield/Ac.	Acres	Yield/Ac.	Acres	Yield/Ac.
Corn	20	30.0	15	42.0	8.0	45.0	14.8	40.0
Corn silage	10	7.5	8	10.0	6.2	11.3	6.0	11.0
Wheat	15	16.6	42	16.3	19.0	12.6	17.7	14.5
Meadow (all)	46	.4	11	1.2	24.8	1.4	34.4	1.8

The type of feed grown and fed to livestock is improving the quality and vigor of young animals at birth. Practically all the heifers are now kept to add to the herd, whereas before many were not good enough quality for breeders. Further proof of the economy of the conservation program is evident in the changes in feed purchased and required. In 1936, 58 percent of hay requirements were purchased and no grain was bought. In 1939, no hay was purchased and only about 15 percent of grain requirements had to be bought.

The efficiency in the operation of the farm may be measured to a large extent by a number of efficiency factors, calculated from the annual farm account records kept on this farm in 1936, 1937 and 1938. These data for the farms are shown in the appendix.

An analysis of the data indicates that the program has not disturbed the farm organization materially or impaired the financial returns to the operator. Indications are that greater returns can be expected. The livestock receipts per tillable acre have not changed much, but the livestock receipts per $1 worth of feed fed have increased materially. Value of crops per tillable acre has decreased principally because of the decreased corn acreage. The livestock efficiency index, which is the percentage of average returns per $1 worth of feed fed, weighted by the kind of livestock kept, indicates that the type of feed now produced is more satisfactory for a dairy enterprise than the old system. The man work units on the crop acres have been reduced, with little change in labor requirements on livestock.

Since the receipts and operating expenses per tillable acre have not appreciably changed, it would lead one to believe that a soil conservation program on this farm fits into the farm organization nicely. A steady rise in the crop yield index is a favorable sign, showing some response on the treatment and use of the cropland.

The average return on investment on this farm the past 3 years has been 12.7 percent, or an average net income of $1,495.

The total expenditure on this farm over and above the usual farm expenses, including labor, was $1,415.16 or $9.31 per acre. The government contributed approximately 60 percent and the farmer 40 percent of the total. This represents the cost of establishing the program on the farm to date.

The cooperator has indicated that he will continue the program indefinitely as it is now planned. He intends to apply some additional fertilizer to pasture and meadow land in 1939. He has on hand 2 tons of 0-45-0 super-phosphate fertilizer and plans to buy some potash next spring to balance his applications.

The pasture and meadow programs on this farm are assuming more important roles because of their necessity for economical dairy production. When the operator ceased renting outside pasture, his enthusiasm for further pasture treatment at home was bolstered greatly. Supplementary pasture from the rotation and retired meadow land has been a large factor in the success on this farm. In the spring of 1937 the cooperator pastured 13 acres of wheat during the month of April with 15 heifers and estimated the value of the forage at $50. For 2 successive years he has been able to leave the yearling heifers on good legume pasture until December before starting barn feeding. The practice of grazing alfalfa-grass meadow on this farm to provide supplementary pasture is being tried.

The strip cropping system has been adjusted to fit both the cooperator's needs and the erosion control needs. With the exception of buffer strips which will be marked out in the spring of 1940, the complete system is in operation.

The cooperator has been doing gully control work every year, using straw and hay mulch and by discing and seeding. There are few raw breaks remaining on the farm. Due to a few steep slopes and low fertility some of the eroded draws have been difficult to heal, but with less plowing and some care, the future gully problem on this farm will be small.

Following are a few comments that have been made by Ritchie from time to time:

"Very noticeable decrease in run-off in large draw back of house since I began using contour strips and have been getting better meadow stands on the watershed above.

"In summer of 1936 my old blind mare walked across the pasture to the treated area to graze.

"My heifers are the nicest I've ever raised and have made the best and most economical growth of any I've ever grown, since I have been able to produce better hay and pasture.

"Pasturing my wheat early in the spring not only gives me some good early pasture, but it protects my permanent pasture when it needs protection most. My wheat yields have not suffered from the early pasturing.

"Top dressing my wheat with manure certainly is good insurance for a catch of grass and legumes."

A general livestock farm.

This is a 170-acre general livestock farm, tenant operated for the past 20 years, on a 50-50 livestock share basis.

The present owner is a widow, Mrs. Quincie Rainbolt, who purchased the unit 23 years ago. She depends on the tenant to supervise and operate the farm business. The farm was known in the past as "The Rail Fence Farm" as it was completely fenced by rails, which came from woodland on the farm. The woods, of beech-maple type, contain yellow poplar, oak and walnut. The farm has been occupied for approximately 100 years.

At the time of acquisition by the present owner the maple trees which had survived were deteriorating. No reproduction was taking place because livestock grazed the woods. Pastures were in poor condition, and only 24 acres of cropland had been limed.

When the present tenant, W. F. Gillum, came on the farm he found fences in poor condition, erosion active on cropland, difficulty in obtaining stands of clover in meadows on account of need of lime and organic matter had resulted in substituting lespedeza in meadow mixtures.

A herd of 25 to 30 dairy cows was acquired. The manure was used preceding corn and as top dressing for wheat, which helped maintain yields. A rotation of corn, wheat or oats and 1 year of meadow, was being used by the operator.

The survey. When Soil Conservation Service technicians surveyed conditions on the farm they found the major portion of the cropland on Bedford Silt loam with 4 to 10 percent slope. However, about one-fourth of the cropland was on slopes of 12 percent or more. The survey showed little gully erosion, not enough to include in analysis. Practically all of the cropland fell into the moderate erosion class. However, the combination of the slope and erosion would indicate the need for erosion control practices and some retirement of the C slope from cultivation.

Before the plan Mr. Gillum averaged about 18 acres in corn with a yield of 40 bushels per acre, 5 acres of silage, 4 acres of oats, 15 acres of wheat yielding 20 bushels, 22 acres of clover and mixed hay, 10 acres of soybean hay, 13 acres of woods which was unprotected from livestock and 76 acres of other pasture.

Table 11A. Planned land use in relation to soil, slope and erosion (Gillum-Rainbolt)

Land use	Total acres	Soil type								Slope					Erosion				
		3	4	34	53	6	72	52	64	A	B	BB	C	D	1	2	3	33	4
Cropland	77.5	53.0	15.0	3.0	3.5	3.0				2.5	25.5	31.8	17.7		4.5	37.8	34.2		1.0
Meadow	18.5	9.0	1.5	3.0	2.0	.5		2.0	0.5	3.0	8.5	1.5	5.5		4.0	8.0	6.5		
Pasture	48.7	4.0	8.7		9.5	25.0	1.5			11.5	3.5	11.5	22.2		17.0	13.5	18.2		
Woodland	18.5	11.5	2.5		3.0	1.5				3.0	6.5	6.0	3.0		3.5	15.5	.5		
Misc.	6.8																		
Total	170.0	77.5	27.7	6.0	18.0	30.0	1.5	2.0	0.5	20.0	44.0	50.8	48.4		29.0	73.8	59.4		1.0

Table 11B. Land use before planning in relation to soil type, slope and erosion classes

Land use	Total acres	Soil type								Slope					Erosion				
		3	4	34	53	6	72	52	64	A	B	BB	C	D	1	2	3	33	4
Cropland	84.7	61.0	9.7	6.0	2.0	3.5		2	0.5	3.0	32.5	27.0	22.2		6	38.0	39.7		1
Pasture	78.5	16.5	18.0		16.0	26.5	1.5			17.0	11.5	23.8	26.2		23	35.8	19.7		
Misc.	6.8																		
Total	170.0	77.5	27.7	6.0	18.0	30.0	1.5	2	0.5	20.0	44.0	50.8	48.4		29	73.8	59.4		1

The 1933-35 average units of livestock on this farm amounted to 4 horses, 18 dairy cows, 10 young dairy units, 6 of hogs and 3 of poultry. Feed requirements for this stock were 60 tons of hay, 1,200 bushels of grain and pasture for 30 animal units. Actual production averaged 77 tons hay, 1,250 bushels grain and pasture for 25 animal units. This analysis indicated inadequate pastures, and observation led to the belief that pasture quality was probably the trouble.

Until 1935 the tenant had two sons who helped with the milking of the dairy herd and the other farm work. After they finished high school they obtained employment elsewhere. The operator had either to hire additional help or reduce his dairy herd, so he began in 1936 to build up a general purpose herd to produce beef calves. This scheme would also fit in well with a soil conservation program which would supply more hay and grass crops. Upon reducing his dairy herd, the tenant thought he could increase the number of hogs without affecting the planned cropping system.

The agreement.

The farm was placed under agreement with the Soil Conservation Service in February 1936. A detailed description, which will show the adjustments in land use and the effect of the program on the farm organization and control of erosion follows. Figure 13A shows conservation survey and land use before planning. Figure 13B shows land use and practices after planning.

Fields 1, 3 and 6 (fig. 13B) had been used as rotation crop fields. As a conservation measure, since erosion and slope made the area desirable for meadow use, field 3, 7 acres, was retired to alfalfa-grass meadow. Field 8, formerly pasture was returned to rotation cropland uses. All the cropland was planned on a 4-year rotation of corn, winter grain and 2 years of grass-legume meadow, using an 84-foot contour strip cropping system. In balancing the rotation, fields 1 and 8 were planned together to grow the same crops on alternate years with field 6, so that each year about 35 acres of rotation pasture would be available after small grain harvest. Ten acres of field 6 were limed at the rate of 2 tons per acre in the spring of 1936. Farm planning technicians laid out strip lines on field 6 in the spring of 1936 and assisted the cooperator in getting them into operation. To speed up the demonstration, and to assist the cooperator in putting into effect some of the recommended practices a limited amount of materials and labor were furnished by the Service. The limestone used on the farm was taken from a quarry in field 4.

No major changes have taken place in the strip layout. A few minor adjustments have been made at the operator's request, where some of the strips were too wide for steeper slopes or the lines were too sharp for satisfactory cultivation. Some of the changes have been made by the operator at the time the strips were plowed.

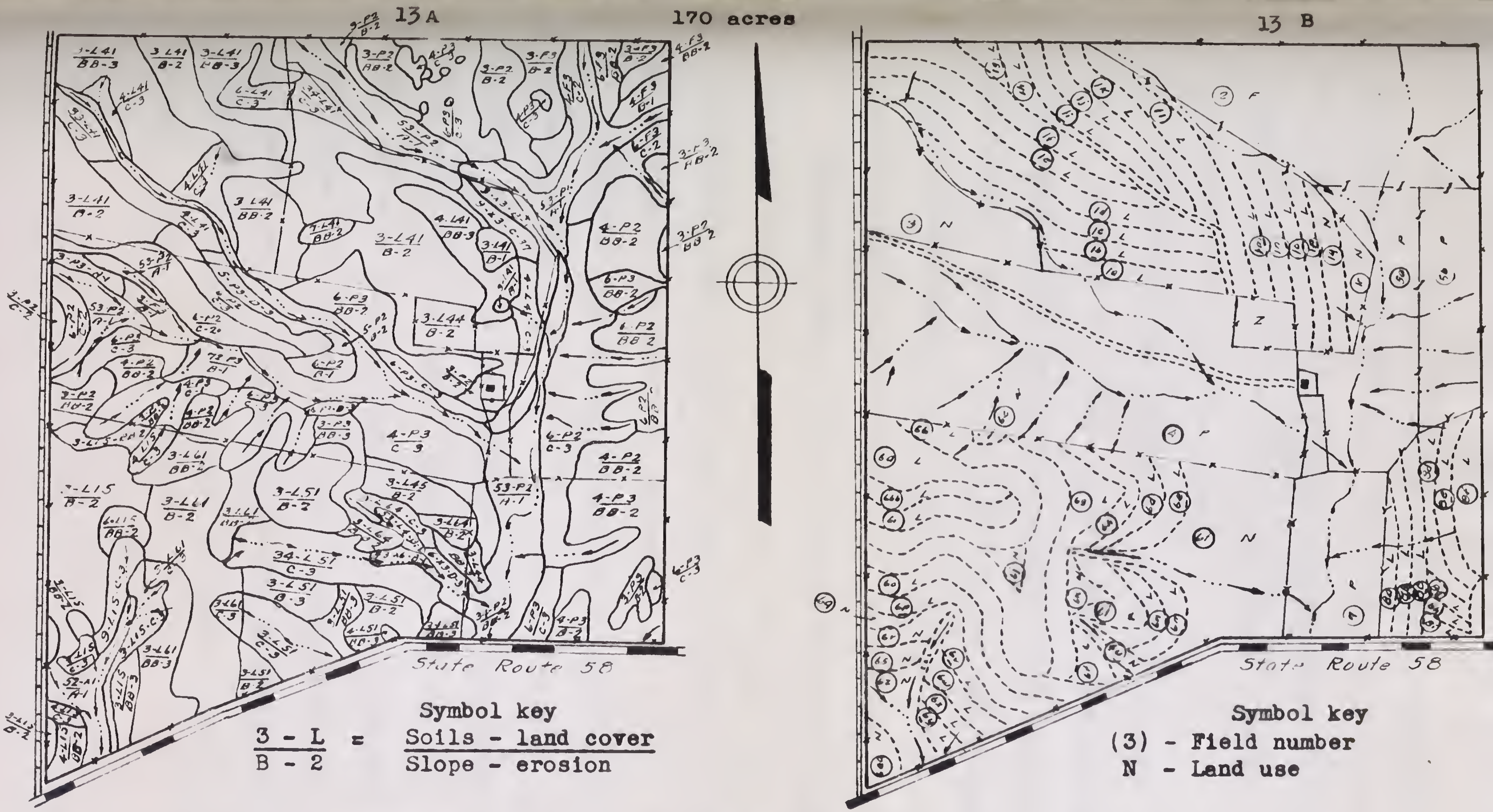


Figure 13 A. Conservation survey map showing soils, land cover, slope and erosion before planning.

13 B. Map showing land use and contour strips on cultivated land after planning. See symbol legend page. 182.

In the spring of 1938, 15 acres more cropland were limed at the rate of 2 tons per acre. About 15 acres of the steeper areas in field 6 were retired to grass-legume meadow. This included about 5 acres in the east portion of field 6, which as originally planned, was retired to pasture.

To alleviate the possibility of rotation meadow failures a "shot gun type" of a grass-legume mixture was recommended. This mixture consists of red clover, alsike clover, lespedeza, redtop and timothy. Better meadow yields are now being obtained in addition to more satisfactory erosion control. Meadow yields increased approximately 50 percent the past 3 years.

The gully control work on cropland consisted mainly of rock fills and brush and litter fills in waterways. Some seeding and mulching was done in draws that would be used for waterways in order to establish permanent vegetation.

Field 3, 7 acres, was plowed and seeded to an alfalfa-grass legume mixture at the rate of 10 pounds of alfalfa and 2 pounds of timothy per acre in April 1936 and drilled with a half seeding of oats as a companion crop. Limestone was applied at the rate of 3 tons per acre, before seeding. At the time of seeding, 0-14-6 fertilizer was drilled at the rate of 300 pounds per acre. For the past 3 years, this field has yielded an average of 2.5 to 3 tons of high quality hay per acre and has effected almost perfect erosion control.

Five acres in the southwest corner of field 4 were treated with 2 tons of limestone and 200 pounds of 0-20-0 per acre, in the spring of 1936. In addition, the same area was contour furrowed, using a 2-foot vertical interval for spacing on a 10 percent slope. The furrows were made by the cooperator, using a tractor and two 14-inch bottom plows. Due to a drouth in 1936, the furrows were slow to vegetate but now they are sodded over (figs. 14A, 14B).

The cooperator has reported complete satisfaction with the original 5-acre treated plot, and feels that similar treatment on some of the other pastures would be beneficial.

As a special study on which an accurate record of cow-days pasture could be kept for the purpose of evaluating pasture treatment under actual grazing conditions, 2 acres in field 5 were treated by the cooperator in the spring of 1937. A part of the area was plowed and the remainder disced. On the whole area, 1.5 tons of lime per acre and 200 pounds 0-20-0 fertilizer per acre were applied. Thirty-six pounds of an adapted grass-legume pasture mixture was seeded at the time the fertilizer was drilled. In the spring of 1938 an additional 4 acres were added to the 2-acre treated area. It was disced heavily, limed at the rate of 1.5 tons per acre, fertilized at the rate of 400 pounds per acre with an 0-14-6 fertilizer and seeded with 16 pounds sweet clover, 22 pounds alfalfa, 18 pounds orchard grass and 10 pounds alsike clover. The treatment was applied in April.

Figure 14A. Contour furrows shortly after construction on 9 percent slope. Mrs. Quincie Rainbolt farm.

Figure 14B. Contour furrows shown in Figure 14A, after three growing seasons.

Accurate records showing cow-days of grazing were kept on this area in 1938 and 1939 in comparison with the cow-days on field 4. This was in connection with a study made on several farms for the purpose of providing information pertaining to the value of treated vs untreated pastures. A report on pasture renovation study has been submitted. An analysis of the records show that on a per acre basis the treated area gave 42 percent more cow-days grazing per acre in 1938 and 40 percent more cow-days grazing per acre in 1939 than did the untreated pasture (fig. 15).

Due to extremely dry weather in the late summer of 1938 and 1939, only about 4 months of actual grazing was obtained from the permanent pastures. In a normal season with controlled grazing at least 6 months of grazing can be expected from the permanent pastures. All pastures on this farm are being managed much better than in the past. They are mowed from one to three times each year when the predominant weeds are in bloom, or when the turf needs clipping for more uniform grazing. The livestock are shifted periodically from one pasture to another to control the height of the grass for most desirable combination of grasses and legumes. The operator reports that his pastures are not only producing good grazing over a longer period but they are also producing a higher quality forage.

Figure 15. View of pasture fields. Area on right above fence is a renovated area treated the spring of 1937. Pasture was limed, disced, fertilized and seeded. Area on left of fence received no treatment.

Field 2, 13 acres, which had been woods pasture, was converted to woodland and protected. In addition, 5 acres of eroded pasture was included in the area and planted to tree seedlings and seed spots, in the spring of 1937. In the spring of 1938, 3,000 tree seedlings of pine, locust and yellow poplar species were furnished by the Service and planted by the cooperator in areas in field 2, that had been drouth killed in 1936 and 1937. Sufficient wire and labor were furnished by the Service to build a fence around the area.

Observation and reports up to 1929 show that since protection the maple sugar grove is improving in vigor and yielding much higher returns. In 1936, $48 worth of maple syrup was sold, in 1937, $86 worth, and in 1938, $140 worth. It is probable that a 3-acre area in the west portion of this field may be returned to pasture uses, as it now has an excellent cover of Kentucky bluegrass. The bluegrass is so dense that tree seedlings were smothered out. With proper management an area of this type would make good pasture and also control erosion satisfactorily.

The coordinated program is fully established on this farm and is working to the satisfaction of both the Service and the cooperators.

<u>Tangible results on the Rainbolt farm.</u> Table 11B shows the soils, slope and erosion in relation to the land use on this farm before planning the program, 11A after planning.

Since all the soil on this farm is of pure limestone origin, the type of soil did not play as important a role in determining the land use as did the slope and erosion. A large percentage of the cropland on the farm now falls into slopes ranging from 3 to 12 percent, having 2 and 3 erosion. About one-half of the meadow acreage is BB and C slopes with 2 and 3 erosion. BB and C slopes, with 2 and 3 erosion, make up the bulk of the pasture acreage. Some of the pastures have been cropped in years past, but due to rock outcroppings, were turned back to pasture. This probably accounts for the fact that 40 percent of the pasture land, though not very steep, shows 2 and 3 erosion. Although the woodland is mostly B and BB slope with 2 erosion, the fact that a large amount was already in maple trees justifies its remaining in woodland. It would not have been practical to fence out separately small areas that should have been planted to trees.

Figure 16 shows changes in crop acres by land use, as brought about by the adoption of a soil conservation program. The changes planned will provide adequate grain, a surplus of hay, and sufficient pasture after improvement by treating.

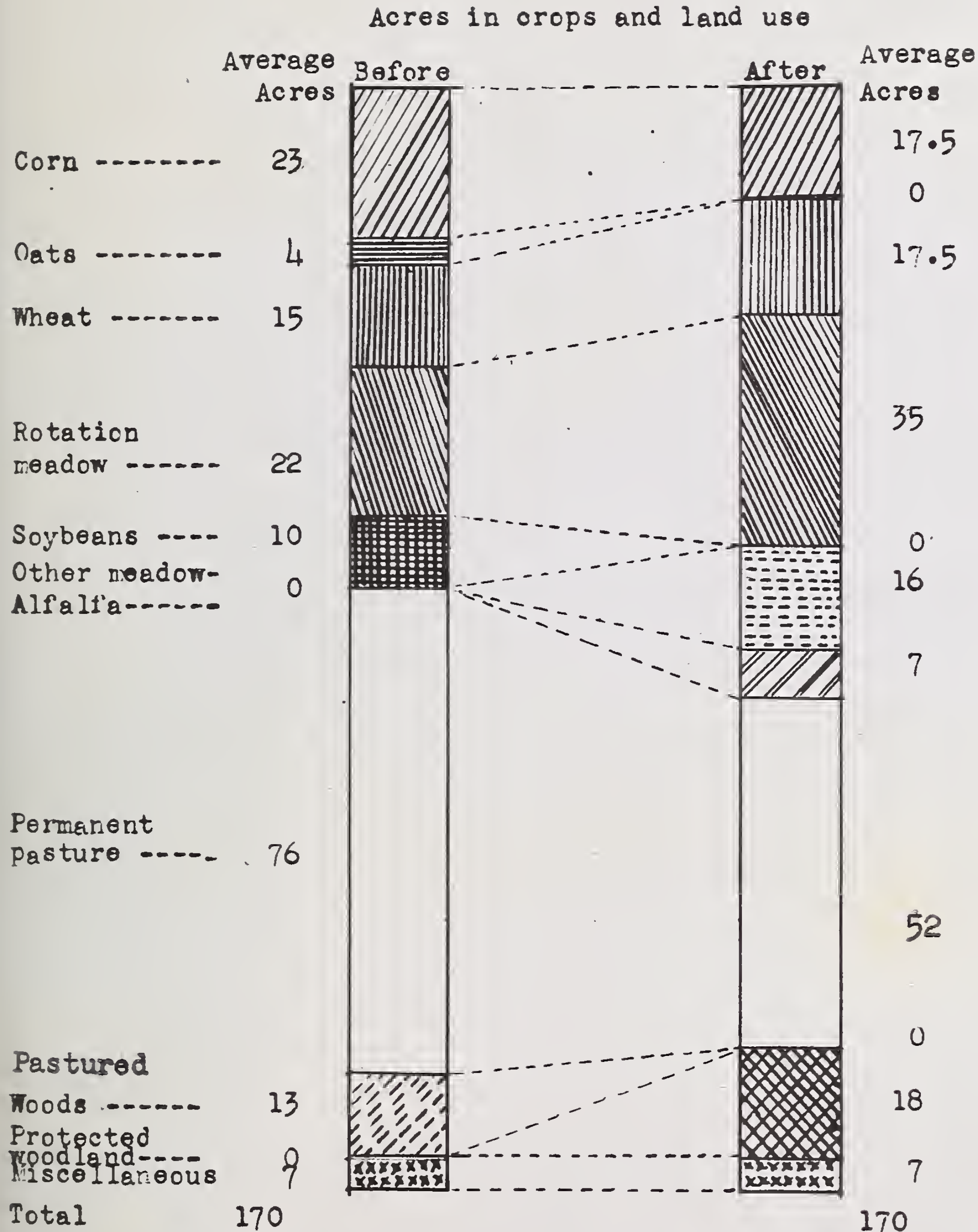


Figure 16. Changes in land use. Mrs. Quincie Rainbolt farm.

Through treatment and management the permanent pastures will carry the livestock load most of the summer. In the fall the rotation meadows can usually be pastured from 30 to 60 days, thus relieving the permanent pastures at a time when they need to store up plant food for winter protection.

The planned program will produce about 15 percent more total digestible nutrients at a reduction in cost of 10.5 percent. This lower cost of production is brought about largely through the increase of close-growing crops, such as alfalfa, rotation meadow and pasture. Also, the elimination of oats and soybeans and reduction of corn acreage would tend to cut down the cost of production.

A study of soil loss from corn strips in field 6 in 1939 showed a negligible amount of soil was being lost from the cultivated strip as compared with the losses which occurred under cultivation of the entire field in straight rows. Mr. Gillum reports that strip cropping has been an effective means of holding soil and moisture in his crop fields.

In the appendix a table is given with data showing some of the economic factors which indicate the results on this farm since the conservation program has been initiated.

The analysis of costs of establishing the demonstration program on this farm shows that the government contributed 85 percent and the cooperator 15 percent. The cooperator will continue methods which have been demonstrated during the agreement period. Complete satisfaction in the program to date has been voiced by tenant and owner. The tenant says that he will never farm rolling land by any other methods than on the contour. He states that although crooked rows and perhaps point rows make tillage more difficult, he has been well repaid for his trouble during the past 4 years because the complete erosion control program on his farm takes out a lot of the gamble connected with farming.

"My corn yields have increased 10 to 20 bushels per acre the past 4 years," the tenant states. "My 1939 crop of approximately 70 bushels per acre is the best I have ever produced on this farm. Also, the beef calves I raised this summer on pasture are the nicest and produced at less cost than any I've ever grown. I sold them in mid-summer at $50 per head. Although I still have some slight erosion in difficult areas on the farm my erosion problem is very slight compared to the old methods of farming."

The tenant also stated that his horses stayed in better condition and could do more work during the heavy cropping season because they did not have to pull up and down hills all day long.

The tenant's wife quoted her husband as saying that visits by the Service personnel were always welcomed because he was sure to learn something helpful from them.

The Soil Conservation Service has been fortunate in being able to work with a tenant-operator of this type. Lack of finances has kept the cooperators from progressing with the program as much as they might have wished but with the attitude they now have there is no question that the soil and water conservation program on this farm will continue to improve as years go on.

A beef cattle farm.

This 220-acre farm is owned by Jesse A. Wood, an absentee landlord, living in a nearby town, and farmed by a tenant on a 50-50 share basis, usually under a 3-year contract. The farm has been in the family since 1830 and has had good care in the past.

The landlord and tenant are both progressive agricultural men with an appreciation of the land and its conservation. Both men realized that something was wrong because of clover failures and irregular yields and were more than glad to cooperate with the Service if practical methods could be recommended and instigated.

The survey. The operator was fertilizing his corn and wheat with an average application of 125 pounds of 2-12-6 fertilizer and had used lime. All the manure produced was put on the cropland. A fair content of humus was to be found, but because of the clover failures and irregular rotation, this was not as high as it should be for best results.

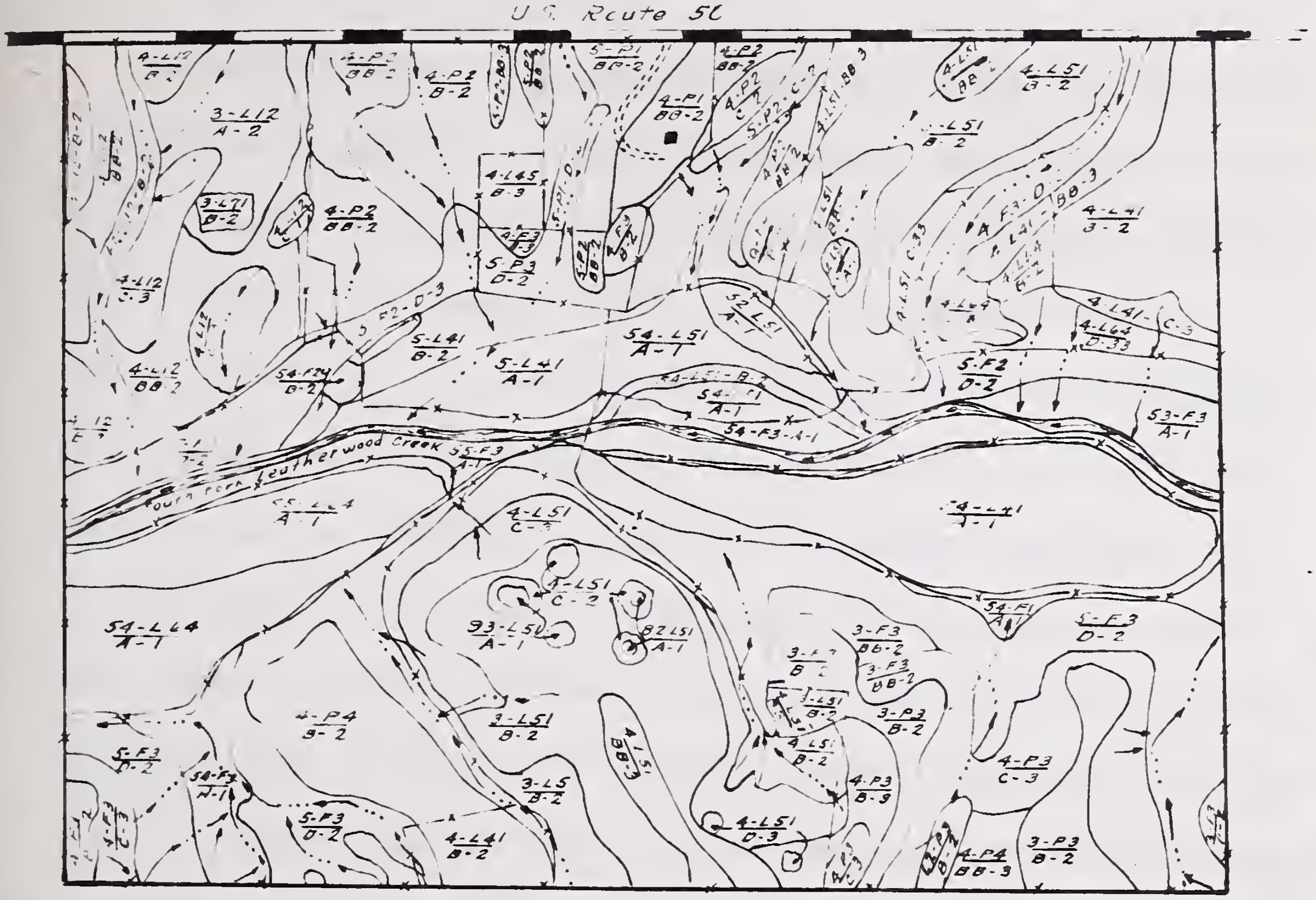
The soils belong in the Hagerstown series and the farm acreage consists of: Hagerstown silt loam, 60 percent; Huntington silt loam, 25 percent; Bedford silt loam, 14 percent and Linside-Stendal silt loam, 1 percent, as shown in Figure 17A.

The upland soils on this farm range from 3 to over 20 percent in slope. The 3 percent slope for the most part has only a class 2 erosion because the topography has forced it to be left under a woods cover. Many of the steep areas are rather inaccessible to livestock for general grazing. Where C and D slopes were in the cultivated fields, the erosion was class 3 and 33. A slopes were generally class 1 erosion and B slopes class 2 erosion.

The upland soils vary in depth from 4 to 10 feet with rock outcroppings on the shallower phases, especially on cultivated areas where sheet erosion has taken place. This condition made it impossible to terrace as a control measure on these fields. Underground drainage is found on some of the upland fields, it being indicated by occasional sinkholes where the surface drainage enters.

The livestock on this farm consisted of almost every class, but a herd of registered Aberdeen-Angus cattle, a herd of grade dairy cows and a small herd of hogs were depended upon for practically all of the income. Horses furnished the power for operating the farm and the operators raised two to three colts a year. The tenant is a good husbandman and is especially good with cattle, so the major emphasis was placed there. Much of the grain fed was bought as well as grain supplements, but an attempt was made to produce most of the hay and all of the pasture. Soybeans played a big part in the production of hay and often were grown in place of small grains.

Jesse A. Wood 220 acres



17 A

17 B

Figure 17A. Conservation survey map showing soils, cover, slope and erosion before planning. 17B shows land use and erosion control after planning. Symbol legends page. 182.

The bottom fields were used a major part of the time to grow corn with some soybeans and oats at periods of three or four years in each field. The upland fields had corn grown on them each third or fourth year, followed by wheat, oats or soybeans, leaving the ground bare over winter much of the time. The owner insisted on the tenant not raising corn on the upland fields any more than necessary so the rotations varied with the tenant somewhat.

All the woods were grazed moderately and the pasture proper over-grazed because of the large livestock load. The pastures were largely made up of Kentucky bluegrass, Canadian bluegrass and white clover. Cropland meadows were used as supplementary pastures whenever they could be spared from hay production.

The agreement. In going over the farm the operators pointed out many problems. They realized after discussion of the soil conservation program that land use adjustments were necessary and some of the erosion control measures discussed could be used. A planned rotation with a uniform acreage of the various crops each year appealed to them. They had a fine conception of the idea of land use and were anxious to have a plan whereby the hay and pasture needs could be met and still maintain the relatively small acreage of corn which they had been growing. As the steep banks bordering the bottom fields, especially on the south side of Leatherwood Creek, presented a problem in reaching upland fields on that part of the farm, it seemed highly desirable to confine the cultivated crops to the bottom fields and upland fields on the north (fig. 17B) providing the erosion problem could be solved.

It was decided to use a 2-year rotation on the two large bottom fields, 14 and 15 (fig. 17B). Field 15 had been a problem field because of the excessive water running down on it from the field above. Almost every year this water kept the field so wet that the operator was forced to plow and plant the corn at a late date, resulting in a low yield of soft corn. A diversion ditch was planned and constructed along this field to remove this condition. The 2-year rotation was corn and winter-grain-sweet clover. The sweet clover was to be used as a green manure crop except in extreme cases of need, such as a bad drouth, when it could be used as an emergency pasture.

The two small bottom fields, 10 and 11, were ideal for hog pasture, so a 3-year rotation was planned for them, consisting of corn, small grain and clover meadow.

Field 1 and 6 were planned for contour strip cropping under a 4-year rotation of corn, winter grain, meadow, meadow, with the exception of the steeper slopes (field 9) which were to be retired. The B slope in field 7b was to have the same rotation as the other two. Since the slopes were short and gentle, contour tillage alone was planned for this field.

The soils were tested and found to need 2 tons of lime on the upland and 1 ton on the bottom land. This has been applied as planned. The corn fertilizer was changed to a 0-12-12 analysis at the rate of 125 pounds per acre and the wheat fertilizer maintained at the rate of 200 pounds of 2-12-6 fertilizer per acre.

Figure 18A. Field to be stripped, with contour lines laid out.

Figure 18B. After strip cropping is in effect on field shown in Figure 18A. A 4-year rotation of corn, wheat, meadow, meadow, is being followed. Alfalfa, red clover and timothy is the meadow mixture used. The operator has been pleased by the effectiveness of the control secured.

Tests showed that all soils on the farm were low to very low in phosphorus.

Field 19 includes a small field formerly cultivated and most of the B slope was planned for alfalfa-grass meadow. The steeper slopes of fields 6 and 7 could not be fenced economically for use as pasture so alfalfa-grass meadows were planned for these areas. Two to three tons of lime were needed and recommended as well as 300 pounds of 0-14-6 fertilizer per acre; the area never to be used for cultivated crops again but to be maintained in meadow through small grain whenever the stand and yield made the production uneconomical.

The pasture acreage was too small to carry the livestock so field 16 was converted from cultivation to pasture. This field had some steep, irregular slopes and several sinkholes, hence did not lend itself to contour strip cropping. A treatment and management plan was outlined whereby it could be made to produce a good growth of high quality pasture. The owner and tenant were much interested in this phase, the tenant even agreeing to bear a small portion of the cost of treatment.

All pastures were planned for treatment with 1 to 2 tons of lime as tests showed the needs and 400 pounds of 0-20-0 fertilizer per acre. Rotation of pastures was planned as far as water supply would allow and the livestock to be kept off of pastures during the winter months. All pastures were to be mowed at least once a year. Steep slopes were to be found in these fields but because of their location and size it seemed uneconomical to fence them out and plant to trees, although woodland was obviously the ideal use.

The steep wooded areas in fields 7 and 8 were too steep for pasture and in many places the rocks lay so close to the surface that they were a hazard to livestock grazing. These areas, together with small eroded adjoining cultivated areas, were fenced from livestock and the open areas planted to locust and pine. Field 12 had several acres of A slope within its boundaries but the land was so gravelly and flooded so often that it was not suitable for cultivation or pasture. It was protected and set aside as woods.

Tangible results on the Wood farm. The operator planned to eliminate the sheep and dairy cattle and concentrate on the breeding herd of registered Aberdeen-Angus. This has been accomplished without reducing the farm income, as indicated by the farm account book. Some increase has been made in hogs, as the practice of hogging off wheat has been instigated with satisfactory results. In 1937 wheat which sold for $1.06 at the elevator brought over $1.50 through hogs. The poultry flock has been increased.

Yields of corn, wheat and hay have shown an increase. The operator says that field 14 has not been too wet since the diversion ditch was constructed. The sweet clover green manure crop has been very profitable. Yields of this field have increased from an average of 40 bushels per acre before to an average of 60 bushels afterward.

The upland fields have produced increased yields, the operator believes because of strip cropping, a planned rotation, the retirement of steeper slopes to meadow and pasture and a better fertility program which has conserved soil and moisture.

The average annual amount of feed planned to be produced during the 3-year period the soil conservation plan has been in operation was 1,100 bushels grain, 87 tons of hay and 40 animal units of pasture. In 1939, the production was 1,955 bushels of grain, 90 tons of hay and 44 animal units of pasture.

Data in tables 12A and 12B show the distribution of land use on this farm according to soil types, slope and erosion, before and after planning.

A pasture treatment program has been carried on steadily until now 45 acres of pasture have received 1 to 2 tons of limestone per acre as needed and 300 to 400 pounds of 0-20-0 fertilizer per acre. Four acres have received 500 pounds of 0-14-6 fertilizer per acre, resulting in a big increase in the pasture yield. On most of the areas the operator believes the yield was almost doubled. On field 20 a mixture of alfalfa and sweet clover was seeded which has furnished an excellent mid-summer pasture. Wheat and rye have furnished some valuable early spring pastures and the operator believes contributed to the resulting meadow stands.

Table 12A. Soil type, slope and erosion according to land use after planning. Jesse A. Wood farm

Land use	Total acres	Soil types									Slope					Erosion			
		3	4	5	9	52	53	54	55	62	A	B	BB	C	D	1	2	3	33
Cropland	65.1	9	21.3			2		26.8	5	1	33.8	21.3	7.0	3		30.8	30.3	4.0	
Perm.Mead.	16.7		16.7									6.7	5.0	3	2		9.7	4.0	3
Pasture	82.5	23	38.0	15.5	1			2.0	2	1	3.0	37.0	16.5	15	11	3.0	58.0	20.5	1
Woods	41.0	4	6.0	19.0			3	8.0	1		12.0	5.0	2.0	1	21	12.0	28.0	1.0	
Total	205.3	36	82.0	34.5	1	2	3	36.8	8	2	48.8	70.0	30.5	22	34	45.8	126.0	29.5	4

Table 12B. Soil types, slope and erosion according to landuse before planning. Jesse A. Wood farm

Land use	Total acres	Soil types									Slope					Erosion			
		3	4	5	9	52	53	54	55	62	A	B	BB	C	D	1	2	3	33
Cropland	107.1	27	43.3			2		26.8	7	1	35.8	42.3	14.0	12	3	32.8	54.3	17.0	3
Pasture	98.2	9	38.7	34.5	1		3	10.0	1	1	13.0	27.7	16.5	10	31	13.0	71.7	12.5	1
Total	205.3	36	82.0	34.5	1	2	3	36.8	8	2	48.8	70.0	30.5	22	34	45.8	126.0	29.5	4

Winter protection of the pastures has been practiced, together with mowing once a year and rotation as much as the available water supply will permit. He believes that these have all contributed to the increased production secured.

Total digestible nutrients produced on this farm in 1933-35 were 233,111 pounds at a cost of $10.63 per 1,000 pounds. In 1939, 256,141 pounds were produced at a cost of $7.56 per 1,000 pounds.

The owner sees the value of protecting his woods and believes that protection of the steeper slopes from grazing is valuable. He realizes that prevention of erosion on these slopes helps the bottom fields from being covered by silt from above. He has placed these wooded areas under state forest classification.

The operator believes that the yields have been increased 25 percent and the value of the farm has been increased $1,000.

The cooperator furnished approximately 30 percent and the government 70 percent of the cost of establishing the program, considering labor and materials.

Figure 19 shows changes in crop acres and land use on this farm effected by the conservation plan.

A small general farm.

This 70-acre farm is located in the eastern portion of the watershed. Although realizing that he had a serious erosion problem Stanley Hunter, the owner, was reluctant to try a method new to his farming experiences. After observing the various control measures on other farms for a year, he decided that they were sound enough to try out.

FIG. 19--Acres in Crops and Land Use

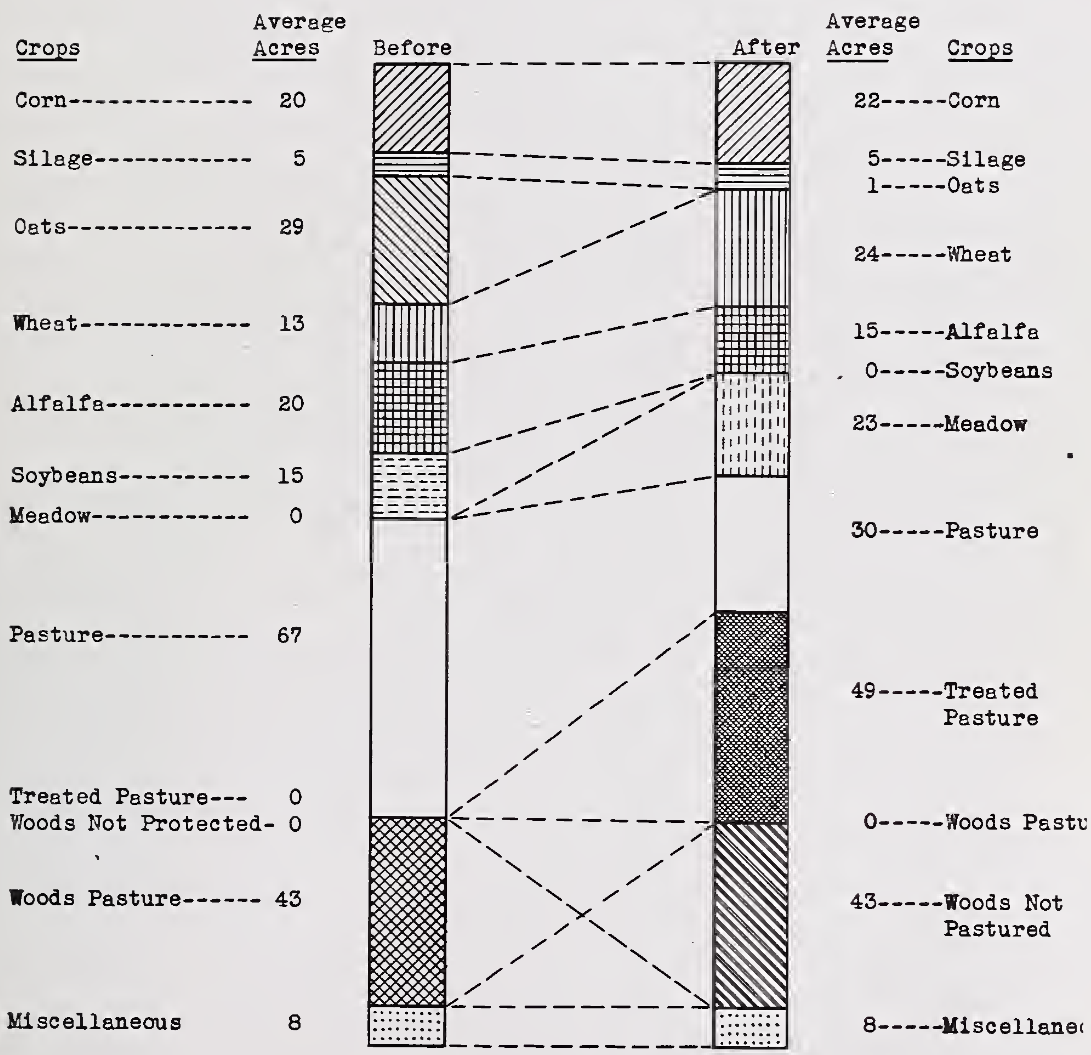


Figure 19. Crop acres and land use on Jesse A. Wood farm.

The survey. Serious erosion had reduced his yields and it was almost impossible to get a good stand of clover or timothy meadow. The humus content was low because of the 3-year rotation of corn, wheat, meadow and the accelerated erosion. Land use adjustments were badly needed.

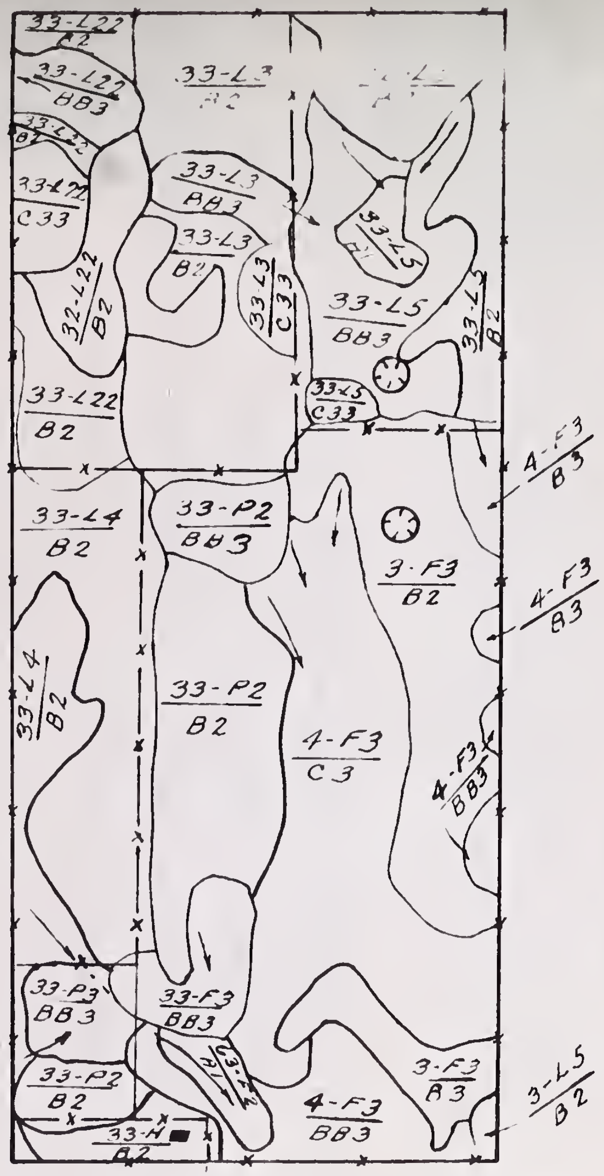
The soils on this farm are derived from both pure and impure limestone; approximately one-third of the soils being of the pure limestone group and the remaining two-thirds of the impure limestone group.

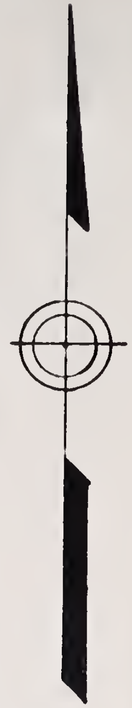
The pure limestone soils have slopes which are irregular and many sinkholes are to be found. Sixteen acres of land on this soil were in forest cover and the rest in pasture. The slopes range from 3 to 20 percent, as shown in Figure 20A.

The impure limestone soils consist of Bedford, Lawrence and 1 acre of Holly silt loam. Thirty acres of the farm are Bedford silt loam, with slopes ranging from 3 to 12 percent, many of them being very irregular. The steeper ones usually showed a 33 erosion, making difficult the installation of erosion control measures such as strip cropping. This soil type made up most of the cropland acreage.

The livestock consisted of a team of horses, 3 or 4 milk cows, 2 sows and 400 to 500 laying hens. The hogs vary from one to four litter of pigs a year. Poultry is the chief source of income with hogs and wood products making up most of the remainder.

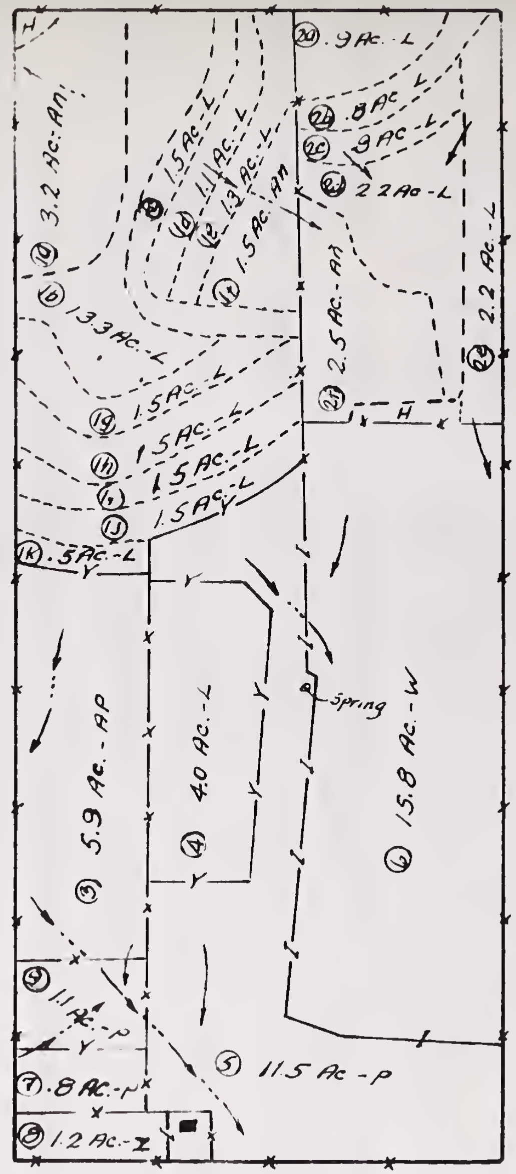
20 A





STANLEY HUNTER FARM
70 ACRES

20 B



Symbol key

$\frac{4 - F}{BB - 3}$ = $\frac{\text{Soil type - Land Use}}{\text{Slope·Erosion}}$

Symbol key

(10) = Field No. - 3.2 acres - An, Land use

Figure. 20 A. Conservation survey map showing soils, land cover, slope and erosion before planning.
20 B. Land use map and erosion control after planning. Symbol legends on p. 182.

Because several acres of the cropland had steep slopes which were severely eroded it was decided to use only the B slopes for crops as far as possible (fig. 20B). Field 4 was land which had been cleared of timber only a few years and from which the stumps had not been removed. This was a low B slope which was being used as pasture. A 4-year rotation was planned for this field with contour tillage as the control measure to be used.

The more level portions of fields 1 and 2 were planned for a 4-year rotation with contour strip cropping, the rotation to consist of corn, wheat, meadow, meadow. The soil tests showed a need for 3 tons of lime per acre. It was planned to lime all cropland at this rate and fertilize at the rate of 125 pounds of 2-12-6 per acre on corn and 250 pounds of 2-12-6 on wheat.

Steeper slopes in fields 1 and 2 were retired to permanent meadow and were to receive an application of 300 pounds of 0-14-6 fertilizer and 4 tons of lime per acre. Four acres were to be sown to an alfalfa-timothy mixture. The slopes were too steep for cultivation and lay in three separate areas, so could not be fenced for pasture.

The crop field 3 was retired to pasture and plans made to lime it at the rate of 4 tons per acre and apply 200 pounds of 2-12-6 and 300 pounds of 0-20-0 fertilizer per acre and seed to a mixture of alfalfa, alsike clover and redtop. The small pasture field 7 was to have contour furrows constructed in it because of the excessive water which caused serious damage to the garden below and gullying along the fence. This area was to be limed at the rate of 3 tons per acre and receive 300 pounds of 0-20-0 fertilizer per acre.

About 16 acres of woods, in which stock grazed, were to be protected by fencing.

Tables 13A and 13B give data showing land use according to soil types, slopes and erosion before planning and adjustments which were made.

Tangible results. Not much change in livestock has taken place since planning the program. The livestock will require 800 bushels of grain, 16 tons of hay and 8.5 units of pasture. Some grain will be bought.

The entire crop acreage has been limed at the rate of 3 tons per acre and control measures established. Yields have increased and no meadow failures have occurred.

Observations have shown that erosion has been reduced to a minimum as no apparent soil loss occurred from the corn into the meadow strip.

Corn yields have gradually increased from an average of 35 bushels in 1933-35, to 55 bushels in 1939. Wheat has increased from 10 to 16 bushels and hay from 1 to 3 tons. The present hay consists mostly of alfalfa-timothy mixture.

Digestible nutrients produced for 1933-35 averaged 49,296 pounds at a cost of $14.23 per 1,000 pounds. In 1939, 69,100 pounds were produced at a cost of $9.24 per 1,000 pounds.

Table 13A. Soil type, slope and erosion according to land use after planning. Hunter farm

Crop	Acres	Soils					Slope				Erosion			
		3	4	32	33	63	A	B	BB	C	1	2	3	33
Cropland	27.5			4.5	23.0		1	21.5	3.0	2.0	1	21.5	2.0	3.0
Meadow	6.7		1		5.7				4.2	2.5		1.2	4.0	1.5
Pasture	17.1		5		11.1	1	1	4.5	9.6	2.0	1	4.5	11.6	
Woodland	16.0	8	8					9.0	1.0	6.0		7.0	9.0	
Total	67.3	8	14	4.5	39.8	1	2	35.0	17.8	12.5	2	34.2	26.6	4.5

Table 13B. Soil type, slope and erosion according to land use before planning. Hunter farm

Crop	Acres	Soils					Slope				Erosion			
		3	4	32	33	63	A	B	BB	C	1	2	3	33
Cropland	33.7			4.5	29.2		1.0	20.0	9.2	3.5	1.0	21.2	7.0	4.5
Pasture	33.6	8.0	14.0		10.6	1.0	1.0	15.0	8.6	9.0	1.0	13.0	19.6	
Total	67.3	8.0	14.0	4.5	39.8	1.0	2.0	35.0	17.8	12.5	2.0	34.2	26.6	4.5

The permanent meadows were limed, fertilized and seeded as planned and are producing good yields.

Six acres of pasture, field 3, have been treated with 300 pounds of 0-20-0 and 200 pounds 2-12-6 with excellent results, as shown in the foreground in Figure 21A.

On field 7 large contour furrows were constructed by turning three furrows downhill and forming by discing and harrowing. This 0.8 acre field received 3 tons of limestone and 500 pounds of 2-12-6 fertilizer and was seeded to rye and 5 pounds of timothy in the fall of 1937. The furrows were constructed in the spring of 1938 and the field seeded to 12 pounds of alfalfa. Two pounds of smooth brome and 1 pound of alsike were sown on the furrows. The rye was pastured off, giving 60 cow-days pasture. The alfalfa-timothy meadow was clipped twice the first year and yielded a ton of hay. The field was covered with triple-awn grass and a few scattered plants of Canadian bluegrass before treatment. An excellent stand of alfalfa-grass meadow was secured, as shown in Figure 21B. This picture, taken in July 1939, also shows one of the furrows, the depth and size indicated by the two men. The furrows are shown in the background in Figure 21A, as they appeared in July 1938.

The gullies along the fences have been controlled and no further damage has been done to the garden below. The furrows have held all the run-off with the exception of one occasion when a 3.5 inch rain was experienced in a short period. This field made 3.5 tons of hay in the 1939 crop year, but the ultimate use of the field will be pasture.

Figure 21A. Pasture established on former cropland in the foreground and contour furrow in background.

Figure 21B. Alfalfa-timothy meadow 1 year after seeding. Note contour furrow, constructed to hold treatment and moisture.

The woodland was fenced from livestock and the owner states that his maple trees have given a more even flow as well as a larger flow of sap during the maple syrup season; the mortality has greatly decreased and a big increase in the number of young seedlings has been observed since protecting.

A count made on a measured plot shows that the number of seedlings per acre had increased from 6,700 in 1937 to 32,600 in 1939, with sugar maple reproduction making up 73 percent of the increase.

A management plan was written by the forester and has been followed by the owner. He has practiced selection cutting and states that the wood acreage has been the most profitable acreage on the farm. He is able to make use of his labor at a labor surplus period of the year, never experiences a crop failure and the cash outlay is small in his maple syrup business. Figure 22 shows the maple syrup enterprise on this farm.

The gross income from 15.8 acres of woodland for 3 years, 1936-38, as shown by the Hunter farm account book is as follows: Maple syrup, $428.85; logs, $223,50; total, $652.35; yearly average, $217.45.

The project forester, in a study of this farm, found that the average annual cost of producing this maple syrup, excluding the farm labor, was $27.38 a year. The forester also states that this is only a fair woodland, but under present conditions, an average harvest of $2 worth of logs per acre per year is a conservative estimate of what the woods will produce.

Figure 22. General view of maple sugar camp, with sugar maple woodland in the background.

Figure 23 shows changes in land use and crops which were made on this farm.

In 1939, the first year the strip cropping system has been in full operation, the owner states that no apparent erosion took place and his yields have almost doubled in 3 years.

The cost of establishing the program was 25 percent for the owner and 75 percent for the government, including labor and materials.

A woodland farm.

This 200-acre Thurman-Thomas farm is located 8 miles northeast of Bedford, in a general farming area where the farm agricultural crops are confined to the creek valley and to portions of the more gently rolling upland. The soils of this farm, particularly on the upland, are chiefly Bedford and Dunmore silt loam, with Muskingum silt loam exposed in steep ravines and along water courses throughout the large wooded area (fig. 24A). The soils found on that portion of the farm given over to agricultural crops are Pope and Holly silt loams on the first bottoms and Tyler silt loam on the second bottoms. Considerable sheet erosion has taken place on the majority of land which was in pasture with little or no erosion occurring on the bottoms. In some old fields, serious gully erosion has taken place.

FIG. 23--Land Use and Crop Acres

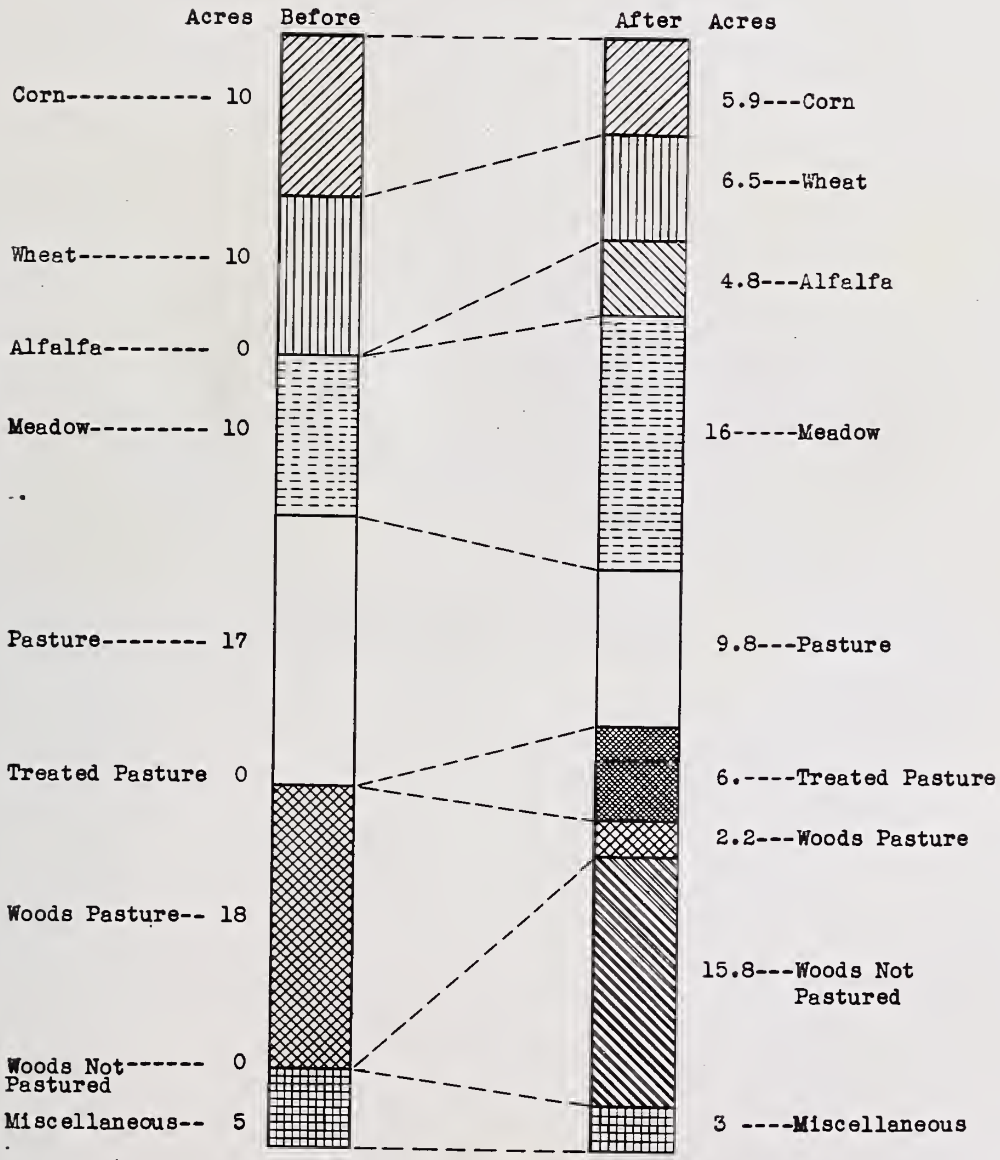
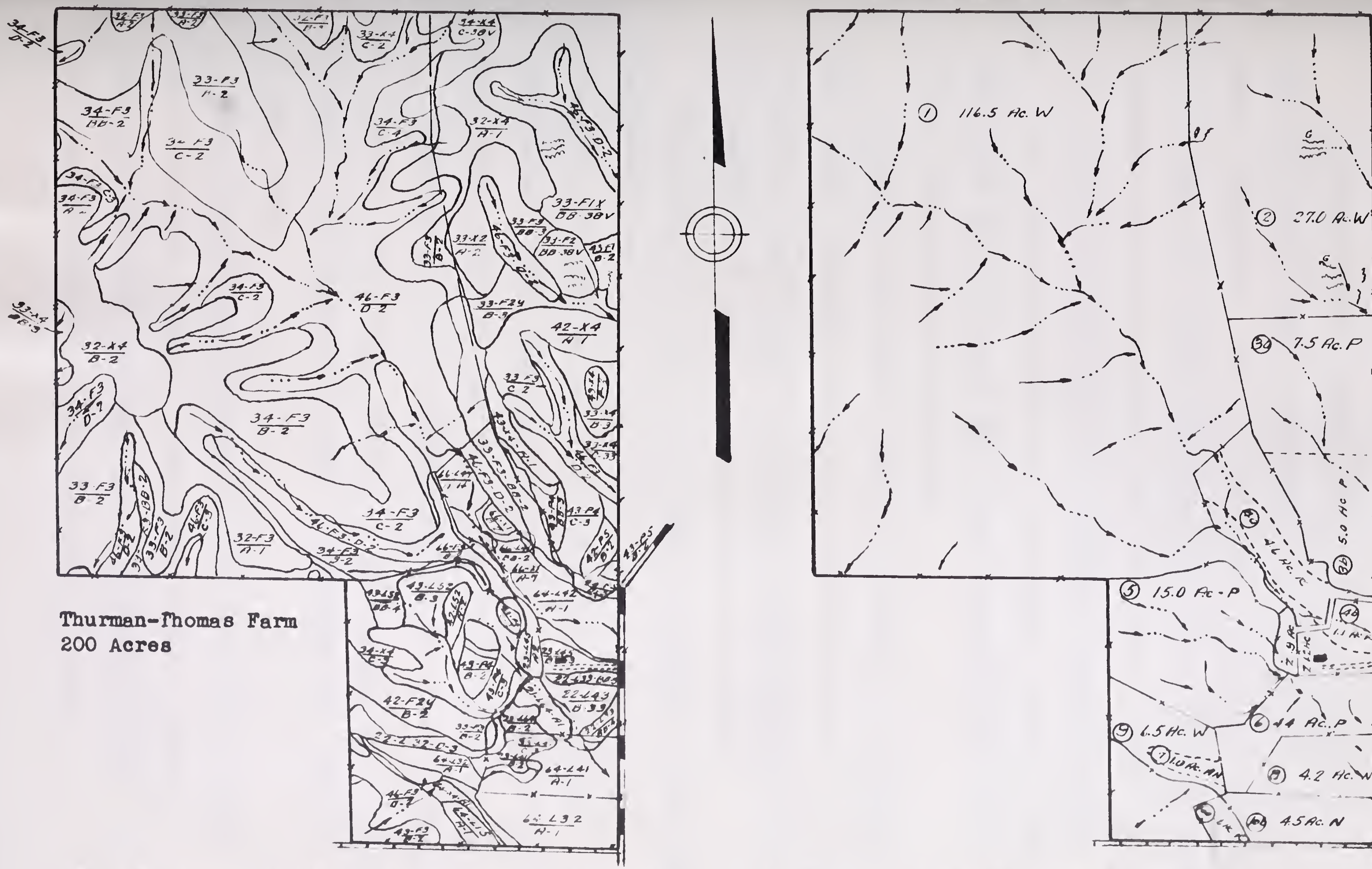


Figure 23.

Conservation Survey Map 24 A

Land Use Map after Plan 24 B



Thurman-Thomas Farm
200 Acres

Figure 24A. Shows soils, cover, slopes, erosion; B, shows land use after erosion control plan on predominantly woodland farm. See symbol legends page 182.

The erosion control program outlined for the Thurman-Thomas farm calls for 150 acres or 75 percent of the total area to be in woodland (fig. 24B). This is in line with good land use conceptions for the area. The program establishes 150 acres of timber for woods management and increases pasture and meadow acres. Fields 7 and 8 were retired from cultivation and converted to permanent meadow. In field 1 approximately 2.5 acres of an opening, formerly an old field along the west side of this field, was planted with 2,500 red pine and protected from livestock.

Field 2 had been used for pasture but because of considerable forest growth and gully erosion, this field was converted to protected woodland. A total of 9,400 black locust and 3,900 shortleaf pine were planted in the openings where planting was necessary.

Fields 3a, 3b, 5 and 6 will be used for permanent pasture, and portions of 5 and 6, and all of 3a were treated with lime and fertilizer and seeded to a desirable cover of timothy, alsike, lespedeza and redtop. Lime has been applied at the rate of 2 tons per acre and 0-20-0 fertilizer at the rate of 200 pounds per acre.

Fields 4a, 4b, 10a and 10b will continue to be used as rotation crop fields. Corn and hay, produced on land owned by this cooperator outside of the watershed, are used to supplement crops grown on the home place.

There were 197 rods of barb wire fence and 43 rods of woven wire fence built, of which 111 rods were to improve pasturing facilities and convert cultivated land to permanent pasture. The remaining 129 rods protect woods areas from livestock.

Since 75 percent of the total area of land in this farm has been set aside for woodland management purposes, the Soil Conservation Service made provisions to include a woodland management plan as a supplement to the cooperative agreement in order to bring about a more profitable income from the farm.

An economic survey of the farm showed that the labor income in 1935 was approximately $170. The pasture phase of the farm management program was improved and woodland management plan was written, providing for definite action program in the woods. The woodland plan called for:

(1) The removal of the remaining dead chestnut as telephone and electric poles, and as fence posts,

(2) The removal of all over-mature beech,

(3) The removal of the inferior species for fuelwood as time permits.

The Soil Conservation Service demonstrated how heavy the cooperator should cut the inferior species for improvement of the stand and also what could be expected from salvage cutting.

The cooperator has worked in the woods to some extent but due to an accident was unable to do justice to the woodland program as outlined by the Service. The amount and value of wood products sold for the past 3 years, 1936, 1937 and 1938:

Chestnut posts, 20-foot telephone poles and fuelwood	$770.50
Electric poles @ $1.50	583.50
	$1354.00

Amount and value of wood products used at home for 3 years:

4,500 bd.ft. chestnut lumber	$135.00
100 fence posts	10.00
Fuelwood	120.00
	$265.00

The woodland work has definitely increased the farm income. This is emphasized by the 1938 farm record book which showed a labor income of $559. for that year. It is assumed, with normal crop production and sufficient time for work in the woods, that the annual farm labor income will be maintained at approximately $600. This was the income estimated in the woodland management plan in 1936.

THE MEASURES OF SUCCESS

Rainfall on the Watershed

Conservation of moisture for drouth periods by control of run-off and resulting erosion has been an over-all objective of the program.

Rain gage records have been kept since the Service began work in the area. One automatic recording type is located at the Service warehouse and two others in the area are kept by farmer cooperators. The average rainfall for 1937, 1938, 1939, taken from these records, compared with the 20-year average, is shown by data in table 14. Observation reports on erosion control practices following these periods of intense rainfall indicate established practices have been effective, with minor exceptions.

Table 14. Average monthly rainfall on Leatherwood Creek watershed compared with 20-year monthly average. U. S. Weather Bureau

Month	1937	1938	1939	1940	20-year average
January	13.16	1.54	5.84	1.27	3.30
February	2.08	2.34	4.15	3.14	2.82
March	1.96	5.48	5.46	1.45	4.02
April	4.36	1.11	5.71	7.89	3.89
May	4.94	4.18	1.16		3.63
June	3.21	2.28	6.48		4.10
July	3.60	4.56	3.49		2.58
August	4.44	2.03	1.90		3.83
September	4.49	1.65	.67		3.47
October	6.28	.77	1.77		3.78
November	1.51	4.58	1.31		3.55
December	2.94	1.49	.91		3.75
Total	52.97	32.01	38.26		42.72

Dates of heavy rainfall	Inches	
May 3, 1937	1.77	
January 3, 1937	1.62	
September 11, 1937	2.84	
October 18, 1937	2.87	
May 24, 1938	1.10	.98 in 1-1/2 hour
July 11, 1938	1.00	
June 21, 1939	.52	in 10 minutes
July 28, 1939	2.63	2 inches in 25 minutes

After four years of improvement and observation of results of the program, it is evident that the battle against soil and water loss, on demonstration farms in the watershed, is being won.

Farmers cooperating with the Service say that erosion losses on their farms have been reduced to a small fraction of what they formerly were. The following recapitulation of results, although recognizing the advantages of long-used farming practices, is made chiefly from the standpoint of erosion control.

Technical Progress

Technical procedure, and improvements in application of practices, contribute an important chapter to this manuscript. Following is a discussion of technical accomplishments with recommendations suggested for adaptation on similar areas.

Agronomy.

Agronomic practices were given major consideration in erosion control work on this project.

The agronomic work has been involved in every important erosion control practice on crop and pasture land. The establishment and use of vegetation of desirable kinds of quality was planned as fundamental in soil and moisture conservation, and economical feed production.

Special studies were made to show the effect of new methods of obtaining and using vegetation on the watershed. Evaluation and results obtained from these tests and studies have been submitted in reports to the regional office, in Dayton, Ohio.

Reports by technicians on results of various agronomic practices are in the project files and are summarized as follows:

Observations on meadow. Alfalfa-grass meadows have been established in the Leatherwood Creek project area by seeding with companion crops and open seedings. Open seedings have been a common practice in the area and they have been made from March until September. Fields were plowed and a firm seed bed prepared. Seeding was with a drill or broadcast and cultipacked. The early seedings have in most cases been as satisfactory as the later seeding, but with no companion crop where seeded in early spring weed control has been quite a problem.

Red clover, 6 to 8 pounds, and timothy 2 to 4 pounds per acre, has been used generally in the watershed for many years. Timothy is the most popular grass used in hay mixtures. The Service recommended fall seeding of timothy in preference to spring seeding, which was formerly a common practice.

Alfalfa, 10 pounds per acre, and smooth brome, 4 pounds per acre, was a new hay mixture demonstrated by the Service. The smooth brome did not become prominent in the hay until the second or third year. This was to be expected from a light seeding, and due to smooth brome spreading by underground rhizomes. From 8 to 10 pounds of brome grass per acre are now recommended in hay mixtures. The smooth brome and alfalfa ripened together, and made a palatable hay. It made excellent pasture and remained palatable even in a mature condition. Livestock did not sort out the alfalfa in preference.

Brome grass made a more satisfactory growth in a dry than in a wet year. It remains to be seen how well it will be adapted here, but trials in meadow mixtures that are to stand longer than 2 years are recommended. Some volunteer brome grass has been growing in the area for several years. Alfalfa-brome grass may prove to be particularly desirable as supplementary pasture in mid-season, when bluegrass is dormant.

Alfalfa-orchard grass mixture containing 10 pounds of alfalfa and 6 to 8 pounds of orchard grass per acre, was also a new meadow mixture. The orchard grass seemed to mature a little ahead of the alfalfa, and some cooperators felt that it made unpalatable hay. This objection might be overcome by cutting the alfalfa-orchard grass at an earlier date. Nitrogen that the orchard grass obtains from growing with the alfalfa should favorably influence its quality and palatability. Orchard grass withstands drouth, is easily established, persistent when established and will make a fair growth on poor soils. The palatability of grasses and clovers seems to be more dependent on their stage of maturity than on the species, the young growth being the most palatable.

Mixtures similar to the 6-4-2-4 mixture made up of 6 pounds of alfalfa, 4 pounds of red clover, 2 pounds of alsike clover, and 4 pounds of timothy per acre have been used with success on the watershed and in a number of the camp areas. In wet years unfavorable to the alfalfa, clovers and timothy made a stand; when dry, the alfalfa made a stand. Alfalfa is a drouth resister, and red clover qualifies fairly well in this respect. There is reason to believe that a mixture of grasses and legumes will out yield any of the species grown singly.

Sweet clover and orchard grass is an excellent combination for soils to which they are adapted, or which can be made favorable to their growth. The orchard grass withstands the shade of the sweet clover. This mixture is particularly well suited for pasture. Orchard grass seed may be harvested during the years when sweet clover is in its first year of growth. Used in this way, this mixture should stand 3 years or longer. Cooperator W. C. Roberts seeded orchard grass and sweet clover on an idle field in 1937. In 1939, 1.9 acres of this pasture carried one animal unit for a 6-month grazing season, and was one of the best in the area. This field was treated with 3 tons of limestone and 300 pounds of 0-20-0 fertilizer in the spring of 1937.

Red clover and timothy, or red clover, alsike clover and timothy do not make a satisfactory second year meadow in a 4-year rotation of corn, winter grain and 2 years of meadow, because it is mostly timothy. Where alfalfa can be grown it should be a part of the mixture, to overcome this objection.

On the poorly drained Lawrence and Guthrie soils, redtop and lespedeza are best adapted with alsike clover fairly well adapted. Soybeans may be used with reasonable success. Timothy is not well suited to these soils, unless they are limed and fertilized. Orchard grass is not well adapted due to the wet conditions of these soils. Alfalfa is least adapted. Red clover and sweet clover may be grown with liberal applications of limestone and fertilizer. Legume-grass meadows have been effective in reducing erosion in strip cropped fields and in rotation meadows.

Cropping systems and practices. Rotations in which legume-grass seedings appear every two or three years are needed for erosion control and to increase the nitrogen and organic matter.

The rotations practiced in the area are 2-year, 3-year and 4-year. The 2-year rotations are found in the creek bottoms and consist of corn, winter grain seeded to sweet clover to be plowed under as a green manure crop ahead of corn again. These fields overflow after a heavy rain but the creek soon recedes into its banks, doing little damage to a winter grain crop. In the past, most of these fields had been in continuous corn for a number of years with a decrease in yields. The 2-year rotation with sweet clover intercrop and the addition of limestone and fertilizer, has increased the yields of corn.

The 3-year rotation used was corn, wheat, winter barley or rye, and clover-grass meadow. The 4-year rotation most widely used was corn, wheat or other winter grain, and two years of legume-grass meadow.

Such rotations are particularly helpful in improving the biological, physical and chemical conditions of the soil. They cause the soil to develop a crumb-like structure, to accumulate organic matter, to be more porous and absorptive of water, to be better aerated, more erosion resistant, and more productive.

Winter cover crops. Winter cover crops of rye and sweet clover have been used following corn and tomatoes, or on land that would otherwise lie bare over winter. The sweet clover is seeded in corn just before or after the last cultivation. In the latter instance, seed before the soil becomes packed and crusted by rain. When rye is used, it is seeded in corn the latter part of September. It provides cover through the winter and adds organic matter.

Italian rye-grass has been tried in a limited way. A mixture of Italian rye-grass and winter vetch seeded in corn during August may prove to be worthwhile for erosion control and to prevent leaching of nitrogen, also for fall and early spring pasture, and for green manure.

Organic matter. Eighty percent of observations on strip cropping mention that erosion control failures have occurred apparently because of lack of organic matter in the soil.

Methods used to increase the amount of organic matter present in the soil have been the addition of manure, a practice in the area for some time and the use of cover and green manure crops such as sweet clover, soybeans and rye.

Rye and soybeans have been most commonly used on the unlimed acid soils. These crops have been used previous to the preparation of the soil for alfalfa meadows or on bottom land in a short rotation.

Sweet clover is used on soils that have been limed or on bottom land with a 2-year rotation. It is used on upland meadows that are to be pastured and in preparing a thin, uninoculated land for an alfalfa meadow.

Increasing the organic matter content of the soils not only increases the productiveness of the soils, but improves the structure of the soil, making it possible to absorb more water. The addition of the organic matter not only increases the absorptive power of the soil, decreasing the amount of run-off, but gives better assurance of obtaining a rotation meadow, which in turn prevents run-off and erosion.

Revegetation of critical areas. Critical areas have been revegetated by seeding and sodding. The areas sodded were sloped, fertilized and sod laid in place. This has been one of the most successful means of revegetating the areas, particularly the heads of gullies.

The areas seeded have been handled by sloping the banks, liming, fertilizing and seeding on a well-prepared seed bed. In some cases the water has been diverted to another area which had a good vegetative cover until the new cover is established. Contour furrows were used to divert all water out of the critical areas. Manure and soil dams were used in establishing sod waterways.

Pastures. Twenty-eight hundred acres or about 34 percent of the eight thousand four hundred seventy-six acres under agreement are in permanent pasture. Since 76 percent of the farm income is derived from livestock and livestock products, the importance of low-cost, home-grown grass and hay for livestock was recognized.

Few pastures were producing a maximum yield when the project started. Many of the pastures were formerly old, eroded fields, from which satisfactory grain and hay yields were not being obtained. These pastures as well as many of the old permanent pastures contained few species of good grasses and legumes, and were thin, weedy, depleted in lime and minerals, unproductive, and subject to sheet and gully erosion. The thin, acid soils were unable to support good stands of Kentucky or Canada bluegrass and white clover, but grew unpalatable weeds, such as broom sedge, triple-awn and poverty grass.

To find ways and means of improving permanent bluegrass pastures for greater erosion control, to supply cheap feed and to increase farm income, the Service conducted pasture improvement demonstrations and studies as follows:

1. Pasture renovation demonstrations.

2. Cow-day grazing records on treated and untreated pastures.

3. Pasture plots planned to determine the effects of increasing amounts of super-phosphate fertilizer.

4. Pasture plots planned to determine the need for nitrogen and potassium.

5. Effects of mowing and grazing control.

Pasture renovation demonstrations. These were conducted on thin sods by liming, discing, fertilizing and seeding to legumes and grasses, including red clover, sweet clover, Korean lespedeza, alfalfa, alsike clover, timothy, brome grass and redtop. The pastures were disced instead of plowed, because of plowing subjecting the soil to more erosion. Limestone was added to reduce soil acidity and fertilizers were used to determine the response of the grasses to nitrogen, phosphorus and potassium. All of these treatments were made in order to make the soil conditions more favorable for the successful establishment of deep-rooted, drouth resistant legumes, which were depended on to stimulate the grasses by providing them with much needed nitrogen. White clover formerly furnished the grasses with the necessary nitrogen when the soil conditions were more favorable for its growth, but it has made only sporadic appearances in recent years. The clovers, of course, are excellent feeds, high in protein, but they serve the dual purpose of furnishing quality feed and nitrogen for the benefit of the grasses.

Renovation results based on three years work on five farms, are summarized as follows:

1. On the Rainbolt farm approximately 3.5 acres of untreated pasture were required to carry an animal unit in 1938 and 1939 compared with only 2.5 acres of renovated pasture. On this farm renovated pastures provided 70.3 cow-days of grazing per acre in 1938, compared with 49.4 for the untreated pasture. For 1939 the corresponding figures were 75 compared with 53.7 cow-days grazing per acre for the renovated and untreated pastures.

2. On the Sam Stipp farm renovation increased the amount of bluegrass from 123 to 424 plants for a given area.

3. On the W. C. Roberts farm a good growth of sweet clover and alsike clover was obtained on the renovated areas. Discing resulted in a more rapid establishment of a pasture sod than plowing. The 400 and 600 pound applications of fertilizer produced more forage than the 200 pound application.

4. On the Cletus O. Fountain farm renovated pastures provided 50.4 cow-days of grazing per acre in 1938, compared with 37.6 cow-days of grazing for the untreated. In 1939 the corresponding figures for the renovated and untreated pastures were 92.9 and 39.3 cow-days of grazing per acre, respectively. In 1939, 4.5 acres of untreated pasture were required to carry an animal unit, while only 1.9 acres of renovated pasture were required to carry an animal unit during a 6-months grazing period. Renovation increased the amount of Kentucky bluegrass and decreased the Canada bluegrass. Limestone alone did not greatly increase the clovers, but a super-phosphate in addition to limestone resulted in an excellent stand of clovers.

5. In 1939 renovated pastures on the D. A. Ritchie farm carried one animal unit to 1.8 acres, while 4.3 acres of untreated pasture were required to carry an animal unit. Renovation increased the amount of bluegrass from 23 to 123 percent.

6. Assuming a daily consumption of 100 pounds of green grass per cow-day on both treated and untreated pastures, the average increase in amount of air-dry forage from renovated pastures on the Rainbolt, Ritchie, Fountain and Roberts farm was 2 tons per acre in 1939.

Effects of increasing amounts of super-phosphate on pasture. Based on the weights of grass clippings on the Cletus O. Fountain farm made in 1937, 1938 and 1939, the heaviest application of super-phosphate, namely 800 pounds of 0-20-0 per acre, produced the greatest average annual increase in yield of air-dry forage, 744 pounds per acre. The increased yield of forage covered the cost of the fertilizer, but was not sufficient to cover that of the limestone, seed and discing. How much additional effect the treatment will have, if any, is not known.

Effects of nitrogen, phosphorus and potassium on production of pasture. Three years of clippings on the Jesse A. Wood farm show that the complete fertilizer produced the greatest increase in yield of air-dry forage, an average annual increase of 547 pounds of air-dry forage. The complete treatment practically doubled the production of forage.

The next highest average annual increase was 503 pounds of air-dry forage from the plot receiving nitrogen and phosphate.

The greatest responses were obtained from nitrogen and phosphorus.

Lessons from the pasture improvement and management studies.

1. In renovating old, worn-out bluegrass pastures, the important thing is to establish deep-rooted, drouth resistant legumes, such as sweet clover, red clover and alfalfa. When conditions are made favorable for the legumes the grasses are apt to take care of themselves by volunteering in the pasture. If grasses uncommon to the community, such as smooth brome are wanted in the pasture sward, they should be seeded.

2. The bluegrass pastures produced most of the forage in late April, May and June. This emphasizes the need for supplementary pastures to provide a longer grazing season.

3. Mowing can be overdone when sweet clover and alfalfa are seeded on pastures.

4. In planning for a full season of pasture the following sequence in use of vegetation may be considered: Winter wheat, fall sown rye or winter barley, bluegrass pasture, second year sweet clover and orchard grass, first and second crop alfalfa or alfalfa-brome grass, second and third crop alfalfa or alfalfa-brome grass, Korean lespedeza, second crop meadow or Sudan grass, first year clovers, bluegrass pasture, first year sweet clover and orchard grass, fall sown rye or winter barley.

5. Mixtures of alfalfa and sweet clover are not satisfactory in renovation seedings, because they require different management. Alfalfa does not stand early defoliation. A mixture of sweet clover and red clover, or one of alfalfa and red clover is satisfactory where soil conditions permit.

6. Management, protection during establishment, provision for supplementary pastures, and sufficient supplies of good hay, proper mowing, and spreading of the droppings in the fall are equally as important as discing, liming, fertilizing and seeding.

Establishment of new pastures shows up best when a good seed bed has been prepared, lime applied well in advance of seeding and sufficient phosphate to supply plant needs for a good start. Manure is helpful as a mulch and starter. A companion crop of small grain seeded lightly will provide winter protection, spring pasture and a seed crop or hay.

Contour furrows have a place in pasture establishment as they can be constructed to a desirable cross section with plow and disc before seeding is done.

The first mowing should be done in the spring when most early maturing weeds are in full bloom. Adjust the cutter bar so as to top the grass. It will favor legume growth and eliminate bunchy areas. The second mowing should be done in August, depending upon seasonal conditions, to control weeds and even up the grass growth.

Scatter droppings with a harrow, wood or chain drag or other available device.

Fertilize and reseed bare or thin spots and keep off the pastures with livestock and equipment when they are too wet.

Over-grazing is perhaps the most serious and common practice among farmers. At some time during the growing season, preferably in the fall, sufficient top growth should be made to provide for adequate storage of plant food in the roots. If made in the fall, additional protection is provided during the winter months. Do not turn stock on pastures in the spring until the grass has attained a height of 4 inches. Do not graze closer than 2 inches. Pastures should be grazed or clipped to 2 inches during May and early June to prevent grass shading and crowding out of clovers. For efficient use and maximum return, uniform grazing at from 2 to 3 inches in May and early June, and from 3 to 4 inches the balance of the year should be maintained. Low-growing legumes, such as white clover and annual lespedeza, will persist if grazed at from 2 to 4 inches.

Manure added to areas continuously grazed will tend to force livestock to graze the more mature or bunchy areas. Frequent clippings will keep pastures nutritious and palatable. This practice should be encouraged when rotational grazing is being practiced. Rotational grazing may be encouraged for dairymen and other cooperators if water and fencing are not serious problems.

Sudan grass, soybeans and small grain are recommended for summer pasture. Small grains, such as winter wheat and rye, when used as a cover crop, will provide fall, winter and spring grazing. Alfalfa-grass mixtures and meadow aftermath will provide summer and fall grazing but must be controlled. (If heavily grazed, remove stock September 1.)

Soils with a Ph of 5.5 or below should be limed and the lime thoroughly incorporated into the soil 4 to 6 months in advance of seeding legumes, especially alfalfa and sweet clover.

Good inoculants and of the right kind are essential to successful legume seedings.

Engineering.

All labor employed on the Bedford project was taken from local relief rolls. This W.P.A. labor was not the most efficient to be desired for the type of work being done.

The winter of 1935-36 was unseasonably cold and considerable lost time was accumulated. Since the W.P.A. labor load was quite heavy, and weather and field conditions were adverse, some of the engineering activities were carried on less efficiently than ordinarily could be expected on construction work of a similar nature.

Limestone quarrying and pulverizing. Bedford being situated in an area where the source of limestone is plentiful and cheap, several quarries were opened and pulverized agricultural lime was made available to cooperators in the project area.

A large percentage of the labor employed during the operations phase of the project was used in preparing this agricultural lime. Three thousand two hundred thirty-seven cubic yards of stone were quarried at an average cost of $3.97 per cubic yard. Due to experience gained in operations methods, the cost of the last 300 cubic yards averaged $1.98, at a labor rate of 50 to 66 cents per hour.

<u>Gully control work</u>. Due to the geological formation, thin residual soil underlain by parent material, and the topography, short slopes with a well defined drainage pattern, the most common types of gullies were those with small drainage areas, varying from a fraction to 4- or 5-acre watersheds. These gullies were usually narrow, from a foot in width up to a 25-foot maximum width and they very seldom had an overfall of over 5 or 6 feet in height.

Large areas were severely sheet eroded but gullies were more spectacular to the ordinary layman, and the gullied areas were the ones that seemed to concern them most. Rock fills were used more extensively than was any other means of attempting to control and reclaim gullied areas. Practically all these structures were built in areas that were out of cultivation.

The first step in the construction of a rock fill was to cut back the overfall and sides of the gully to a slope of approximately 3:1, tamping the loose soil well in the bottom of the gully, so that the rock would have a stable foundation.

The rock was selected and laid so that the entire mass was well keyed together. To prevent "rat-holing" the small interstices between the rocks were filled with litter and small spalls. The fill was constructed with a low center to add to the capacity and to confine the discharge.

A total of 263 rock fills were constructed on 43 farms in the watershed. The average cost of these fills was $11.63 each. The average volume of stone used was 2.5 cubic yards/structure.

Many of the gullies so treated could have been shaped and sodded to better advantage and with less expense if done in the spring or fall of the year; but seasonal and labor conditions and the abundance of available rock made rock fills best suited at that time.

Observations to date have shown some failures, the stone having been moved out of place by high velocities and natural settlement. Vegetation has not reclaimed the eroded areas as it is impossible for it to become firmly established upon the rock. As soon as the rock sloughs down and is moved out of place there will be no vegetation well enough established to control erosion in many of these fills.

Brush and litter fills were used in locations where rock was scarce and in cultivated areas where the use of stone would have hampered tillage operations. In the construction of a brush and litter fill the gullies were sloped in the same manner as they were for a rock fill. Next a fine layer of litter or very fine brush with alternate layers of coarse brush properly compacted were put in place. The whole mass was staked down and wired in place to prevent excessive scouring underneath the structure. Two hundred fills of this type were built. Average volume of material per structure was 7 cubic yards.

Observations to date indicate that these structures have been successful in most instances, catching silt and debris and enabling vegetation to become established.

Sod was used in several gullies. The gullies were sloped and widened into channels which were sodded. Some of these gully lips were sloped back into a sod flume effect. Many of the gullies could have been sodded in the above manner, with much better results than those obtained by mechanical means.

Lenonet mulch, which is a fibre mesh of jute or hemp with one-fourth inch openings was used in mulching raw and sheet eroded areas and small drainageways that had been previously treated and seeded. This type of treatment was used on 20 critical areas on 11 farms on the watershed. The use of Lenonet proved to be beneficial in establishing vegetation on these areas.

Diversion ditches were used on several farms to divert water from gullies and critical areas to channels that were stabilized. The length of these ditches was from 50 feet up to a maximum of 400 feet.

The construction of these ditches was accomplished by hand labor or team, plow and slip scraper methods. The discharge from the diversion ditches was carried to natural stabilized waterways or was spread on good pasture areas.

Observations the past 2 years have been that many critical areas and gullies could have been reclaimed more quickly and with less expense by the use of diversion ditches to intercept the drainage from these areas than has the extensive mechanical structure control. No doubt a system of strip cropping and diversion ditches could have been used on several of the longer slopes where soil conditions and outlets were available to give a much better control than the use of strips alone. Diversion ditches would have at least been very beneficial in years when the meadow strips were not good.

Masonry structures used in gully control proved satisfactory in most instances, but the cost involved for labor and materials does not justify their construction in this area except in rare instances where the gully has an active lip with an overfall of 6 feet and a very large discharge.

Fifteen masonry dams were constructed on 8 farms in the area. The average cost for these structures was $94 each and the average volume was 6 cubic yards, making the cost approximately $16/cubic yard of masonry. There have been no failures of any of these structures.

Forestry.

The forestry division was responsible for all woods improvement and tree planting, and in addition, the work program of fence construction.

The woods improvement program, for the most part, dealt with the salvaging of dying, diseased, poorly formed and inferior trees. Woodlands varied from well-stocked woods of good species to poorly-stocked woods made up of scattered good species. In many instances fire-scarred trees, hollow beech, and dead chestnut were the principal trees removed. The woods improvement on 34 farms, a total of 254 acres, adequately demonstrated the methods by which the farm woodland owner can accomplish profitable and sound woods management.

The amount of products removed in treating 254 acres was as follows: 7,454 posts, 112 braces, 155 telephone poles, 1,219 cords (4' x 4' x 8') of fuelwood and 4,766 board feet of saw logs.

In several woodlands, the removal of over-mature beech brought about the establishment of a favorable stand of desirable reproduction. No special effort was made to follow any specific method of silvicultural treatment because of the condition, both as to number and size of desirable species. Figure 25A shows a woods shortly after improvement cutting and figure 25B shows the same woods 3 years later.

All tree tops and branches were lopped and scattered to form a protective cover against the excessive loss of soil moisture. The by-products of woods improvement were properly processed and left in the woods for seasoning.

Figure 25A. Woods improvement cutting. Made in winter of 1935-36. North to west slope of 20-30 percent. Mixed hardwoods. Underplanted with walnuts, using nuts.

Figure 25B. Conditions of woods in spring 1939. There were numerous buckeye sprouts started.

Tree planting was not a major phase of the Service's program in the Leatherwood Creek area. A total of 427,000 trees were used in planting eroded areas and old fields on 41 farms. In 1938, 24 farmers planted approximately 42,000 trees through the facilities of hired labor at $4.50 per thousand trees, for program improvement.

Black locust was used to a limited extent, for gully planting alone (figs. 26A, 26B). The open fields in and around woodlands were planted to pine. Because of past treatment and erosion of these areas, hardwood reproduction had failed to re-establish satisfactorily in these open fields.

Special methods to encourage the establishment and growth of planted trees were used to some extent. A few areas were mulched with straw and others with sawdust. Results of these measures were gratifying. Establishment and growth were increased to a marked degree. To date, trees fertilized with a complete fertilizer of 2-12-6 show an average of approximately 5.5 to 8 feet increased height growth after 4 to 5 years of establishment. There is a decided lack of diameter growth and root development in the unfertilized trees while in the fertilized trees, root development and diameter growth have been influenced greatly.

A modification of the center hole method was used in planting trees. Excellent results from this method of planting are attested by good survival of trees during the drouth of 1936 when the majority of other plantings in the state failed.

Figure 26A. Gully on Hagerstown soil as it looked at time of planting to black locust and shortleaf pine, in the spring of 1936. Head and banks of gully were sloped, seeded to lespedeza and mulched with brush.

Figure 26B. The same gully planting as it looks after three growing seasons.

On the whole, the results of the woodland improvement demonstrations have been favorable. They have shown the farmer what he can expect if improvement is done by removing deformed, over-mature and inferior trees but not removing all desirable species.

In one particular woods of maturing beech, the Service demonstrated how large an opening should be made in this type of woods to obtain reproduction of desirable species.

Observations on the results of woods improvement to date, show that in the majority of beech-maple woods the cultural improvement should be severe enough to make openings of sufficient size to permit the establishment of light-seeded species.

Protection of woodlands from grazing has been valuable. As a result, natural regeneration has taken place. Observations point out that in some woodlands the natural reproduction has increased as much as 83 percent through protection from fire and grazing. See Figures 27A and 27B, showing the 2-year results of protecting woodlands from grazing on a watershed farm.

The influence of proper woods management upon the farmers cannot be measured accurately at this time but generally the woodland owners have learned to do the processing of timber products themselves and consequently earn a farm labor income during the time of year when other sources of farm income are low.

Figure 27A. Woodland as it appears before being protected.

Figure 27B. The woodland shown in Figure 27A after 2 years of protection.

Forest planting. The limited use of black locust in gully erosion control is justified by the results observed to date. In practically every instance where black locust was planted on Frederick and Lawrence silt loams, and in some cases on Bedford silt loam from cherty limestone, the growth of these trees was decidedly poor. On Muskingum and Frederick silt loams, it was found that mulching, either through the use of straw or sawdust, was beneficial to locust growth for the first couple of years but after that the rate of growth decreased rapidly. Figure 28 shows the results of sawdust mulching on a south slope where black locust was used on slightly sheet eroded areas. The results of mulching planting sites is reported in detail from observations made by Oren, Craig and Erikkson, in 1938[3].

The results of planting black locust in gullies have been fairly good. The best gully erosion control through the use of trees was obtained on Hagerstown silt loam, closely followed by plantings on Bedford silt loam. It was found that because of the ability of eroded Muskingum silt loam to hold water and because of its looseness, that black locust grew well on this soil type.

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[3] Summary Report on Mulching Planting Sites.

Figure 28. View of mulched and unmulched locust planting, on Hagerstown silt loam. Locust on the left in the picture was mulched with sawdust at time of planting 2 years previously.

Only two plantings on conifers had been made in the watershed prior to the use of them by the Service in 1936. At first the farmers were dubious about the use of pines on their farms because of what had happened when Norway spruce was planted on a farm in 1932. Shortleaf pine was the species most commonly used. It was planted generally on old fields where hardwoods had failed to re-establish by natural regeneration. Pitch and Virginia pine were used to some extent on areas where erosion had exposed the subsoil. The results of coniferous planting has been very promising, with shortleaf pine attaining an average height of 4 feet to date.

It is recommended that white pine should be used only on north slopes were sufficient topsoil is present, and also where moisture conditions are favorable. Red pine has not done very well in this area and generally should be planted only to a limited extent. Shortleaf pine will be the species commonly used with varying amounts of pitch and Virginia pine, depending upon the erosion.

Black locust should be planted only on well drained soils and a complete fertilizer having a high phosphorus content should be used at the time of planting. This is verified by observations of Johnston C. Craig on fertilized plots on the area and reported in a study summary, December 1, 1938.

For the most part, gully erosion can be controlled through the use of vegetation, including trees, grasses and legumes, and by natural revegetation through protection. Mechanical structures in erosion control should be limited to a marked degree in this area. Protection of critical areas by the use of a fence to exclude livestock is perhaps the most economical way a farmer can control erosion on small areas.

The proper and judicious use of the axe and saw in maintaining the most trees of different sizes and ages on any acre of woods at all times is the aim of good woods management. The goal of every woods owner should be toward an area of timber which will yield him fuel wood, posts, barn timbers, ties and logs, and at the same time furnish desirable cover for all forms of wildlife. The proper management of the farm forest will result in a more prosperous agriculture, add to the beauty and comfort of the farm home and increase the value of farm property as an investment.

Wildlife.

Wildlife management to some extent was urged when the cooperative agreements were signed. The first year this was accomplished 100 percent on the 46 cooperating farms. To date, approximately 90 percent of the cooperators have made special efforts to improve wildlife environment.

In the winter of 1935 and 1936, 16 feeding stations were established and maintained to help wildlife survive the severe winter. During the spring of 1936, a total of 7,499 plants and 24,740 seed spots of 17 species of woody plants (perennials) valuable for wildlife were established in the area. Later that spring, 42 winter food patches were planted with 490 pounds of seed including 9 special of grain and other annuals producing valuable winter foods.

Due to an unfavorable growing season, the 1936 spring plantings showed poor survival. Consequently, in the spring of 1937, more plantings were made to the extent of 19,552 plants, including 27 woody species of high wildlife value. This time a more favorable growing season permitted a much greater survival; but even so, the percentage survival, taking the watershed as a whole, would be classed as poor. This is undoubtedly due to the fact that many of the planting areas were suited to only low fertility requirement species.

As stated above, during the summer of 1936, 42 food patches were established in the area to furnish winter feeding material. Also in the summer of 1937, 28 food patches were established on 17 farms, using a total of 276.5 pounds of seed. Together with the labor, this was largely furnished by the farmers.

These food patches varied from one to two per farm and ranged in size from 0.1 acre to 1.5 acres. Most of them were, however, less than 0.5 acre in size. They were placed usually on some small piece of land that was fairly fertile, but perhaps inconvenient to use for cropland, yet in a place readily available to wildlife. In the planting of these patches, 9 species were used. Those included were: Milo maize, corn, white kaffir, sunflower, black Wilson soybeans, Manchow soybeans, Japanese millet, Sudan grass and buckwheat.

Casual surveys on several of these farms from September 1936 to January 1937, inclusive, showed that eight species of song birds and one of game birds were utilizing these food patches. Quail and Junco were using all patches observed; tufted titmouse were observed in six, cardinal and Carolina wren in four each, Chickadee in three, mourning dove in two and horned lark and towhee in each. This should not be considered as an accurate or representative survey, but merely gives a rather general idea as to some of the species that utilized these areas.

During the fall of 1937 one instance was noted in which quail were using a food patch for roosting cover as well as for food supply. In this particular food patch, buckwheat was still reseeding to some extent in the summer of 1939, although the original seeding had been in 1936. Another point of interest in connection with this particular area is that on June 25, 1939, 18 out of 19 quail eggs hatched in a nest about 1 rod from the old food patch. These results tend to indicate that food patches, especially during severe winters, are of considerable value to wildlife in the project. However, the general conclusion is that they are not practical here. From the farmers' viewpoint, it seems to be too much trouble and takes too much time from other more profitable work for the returns he gets from the patches.

Besides establishing food patches and maintaining several winter feeding stations, definite wildlife areas were established on many of the farms. While the food patches and feeding stations were of considerable importance, there was a definite need for a more permanent type of improvement in the wildlife habitat -- something that would make good cover and food available during the entire year. This need was accomplished by setting aside small and scattered areas of waste land on various farms to be protected from fire, grazing and cultivation and planted to perennial plants of value to wildlife.

These areas were usually small, varying in size from a few tenths to 5 acres. Of the 27 such areas now maintained, they may be classified into the following types of sites:

1. Woodland border.
2. Gullies.
3. Eroding hillsides.
4. Galled spots.
5. Pond areas.

Woodland borders consist of areas around existing woodlands and around areas recently planted. There are nine such areas at present. Before they were established, most of these areas were in fair condition, none having extremely serious erosion and all having some vegetation. From the plant production standpoint these and the pond areas were the most favorable.

Gullied areas, badly eroded sections where there was little or no vegetation, were considered waste land no longer of any value for cultivation or grazing. Most or all of the topsoil was gone, leaving only rather sterile subsoil for the planting site. Where high requirement species were used there was poor survival and slow growth.

Galled spots were small areas of wasteland that were almost devoid of vegetation and with erosion fairly active, thus leaving no economic value in this barren state; but by planting and protecting from grazing, a protective cover of vegetation was soon established which was of value for food and cover. Lespedeza and redtop mixtures were used on such areas (fig. 29).

Figure 29. Farm pond in the project area constructed by Soil Conservation Service. Fenced part is a protected wildlife area with natural reproduction along borders.

Hillsides that are too steep for cultivation and not of special value for grazing make up another type of planting site. There are six areas of this type. Most of these were characterized by sheet erosion, but not deep gullying -- in some cases this being due to over-grazing. Here again there was little vegetation and consequently no food or cover for wildlife. But with protection and favorable growing conditions these areas are not forming good food and cover patches.

Pond areas that were protected from grazing and trampling by livestock were planted with shrubby wildlife species. These areas usually had fair soil and with sufficient moisture there was good survival of many of the species planted. Besides being of value to wildlife, these plantings tended to control erosion about the pond and helped keep the water clearer and better for livestock (fig. 30).

The effectiveness of strip cropping.

The value of strip cropping for erosion control is accepted. However, due to the newness of the practice in this area a special study has been made in Region 3. A report of the study has been made by Dr. R. W. Gerdel[4].

At this project, observations and measurements showing the amount of soil deposited in fans in meadow strips below corn strips were made. Measurements were made according to methods described in instructions issued by Dr. Gerdel. A summary of results on this study was made in a special supplemental report for Bedford project, 1939 and 1940. A total of 14,612 linear feet of corn strips were measured in September 1938, 15,515 linear feet in 1939.

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[4]Studies of factors influencing the effectiveness of strip cropping. Annual reports 1938-39-40.

Figure 30. Steep break within cultivated area covered with natural vegetation which affords food, cover and nesting purposes for wildlife.

In tables 15 and 16 are presented an analyses of the data for deposited losses from cultivated strips on Hagerstown and Bedford silt loam. The inter-relationship of slope, watershed length and contour divergence is effectively shown in these analyses of the data. It is apparent that watershed lengths in excess of 299 feet on slopes above 4 percent contribute to rapidly increasing deposited soil losses. Also, that contour divergence in excess of 2.8 percent causes a rapid increase in evident erosion.

Since there were no strips reported from the Bedford project area on slopes steeper than 14 percent, it is not possible to determine a critical value for steepness of slope, except as previously mentioned in connection with length of watershed. It would appear that length of watershed and contour divergence are the predominant factors influencing erosion from cultivated strips in this area. Contour divergence in the Bedford area can be attributed, for the most part, to the presence of old draws and shallow gullies so dissecting the fields as to make close adherence to the contour impracticable when inter-tilled crops are grown.

Although the data in table 16 appear to indicate that Bedford silt loam is more erodible than Hagerstown silt loam under strip cropping practices, this fact has not been substantiated by detailed analysis and comparison of strips on these two soils with strips on other residual soils. The apparent differences in deposited soil losses shown in this table may be attributed to the difference in length of watershed and contour divergence associated with each of these soil types rather than to any pedological differences.

Table 15. Influence of length and steepness of slope on deposited soil losses from all cultivated strips on Hagerstown and Bedford silt loams. 1938

Soil type	Length of watershed	Steepness of slope, percent		
		0-4	5-9	10-14
		Deposited soil loss, tons per acre		
	feet			
Hagerstown and)	0- 99	0.2	1.3	0.8
Bedford silt)	100-200	1.1	3.7	3.0
loam)	300+	-	13.5	-

Table 16. Comparison of mean deposited soil loss and some large deposited losses with their associated influencing factors. Cultivated strips on Hagerstown and Bedford silt loams.

Soil type	Measurement	Deposited soil loss	Influencing factors		
			Contour divergence	Steepness of slope	Length of slope
		T/A	percent	percent	percent
Hagerstown silt loam	Mean	1.1	2.8	8.9	187
	large-loss strips	10.5	8.0	12.0	228
		8.0	1.0	7.0	360
Bedford silt loam	Mean	4.9	2.5	7.2	159
	large-loss strips	26.1	2.0	8.0	345
		15.4	9.0	8.0	366

Since practically all the strips reported from the Bedford project were 84 feet wide, there is no available date to indicate any critical value for strip width. However, the analysis of data from strips on other residual soils indicates that no difference in erosion from cultivated strips between 28 and 84 feet in width may be expected, providing all other influencing factors are constant.

The lack of influence of strip width on evident erosion is further substantiated in the report of the Zanesville Erosion Experiment Station[5].

It would appear that the conservation practice of narrowing strips will not alone offset steepness of slope nor length of watershed so long as the rotation remains unchanged. Regardless of strip width, under any rotation, equal amounts of clean-cultivated soil are exposed in a strip cropped field. Results would appear to indicate that narrowing of the cultivated strips, in an attempt to achieve more effective control of erosion, should be accompanied by an increase in width of vegetated strips. This would probably be best accomplished by use of a 6-year rotation, involving two vegetated strips between each cultivated strip.

From this cooperative investigation of strip cropping on Hagerstown and Bedford silt loams on the Bedford project area, the following tentative conclusions appear to be warranted:

1. Erosion from cultivated strips on these two residual soils seems to be influenced largely by length of watershed and contour divergence.

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[5]Progress Report of the Northwest Appalachian Soil and Water Conservation Experiment Station. Zanesville, Ohio.

2. Although the effect of steepness of slope cannot be entirely determined from these soils, the fact that no significant differences were found between these two soils and Muskingum and Westmoreland silt loams indicates that steepness of slope can become an influencing factor. Even on those slopes greater than 5 percent in the Bedford area, watershed lengths in excess of 299 feet caused rapid increase in evident erosion.

3. Strip width, within the limits of 28 to 84 feet, does not appear to materially influence the effectiveness of strip cropping where a 4-year rotation is used.

4. The proportional amount of cultivated land and sod, or other close-growing vegetation on the watershed above the strips, influences the erosion control effect of strip cropping.

5. The use of diversion ditches at suitable intervals has proven to be a method of breaking long slopes and increasing the effectiveness of erosion control.

6. Severe previous erosion greatly retards the effective control value of strip cropping.

7. Where natural draws and old gullies dissect the fields and old gullies dissect the fields and make satisfactory adherence to contour difficult, the use of sod waterways has greatly increased the effectiveness of strip cropping.

Figure 31. Contour strip layout on Cletus O. Fountain farm. Previous to the strip cropping, the roadways were often covered with silt at the corner. This has not occurred since strips were established. Note sod waterways across cultivated strips.

As evaluated by the procedure used in this investigation, 100 percent control of soil loss was attained through suitable use of sod waterways.

Physical Accomplishments

Eighty-eight farmers cooperated with the Service in the demonstration program.

These farms represented 8,669.4 acres, which was 34.6 percent of the watershed acreage. Two of these farms have been lost due to death of owners, two on account of change in ownership. The first agreement was signed in January 1936. The last agreements were signed in July 1937.

Today, 84 cooperative agreements are in force, covering 8,476 acres. Because of weather conditions, time necessary to make changes and other uncontrollable factors, only 90 percent of the plans have been completed. The estimate of technicians is that approximately 80 percent of the cooperators will continue with plans developed by them and the Service.

Tables in the appendix show respectively the degree of program establishment, the land conversions, the summary of accomplishments, and the degree of practice establishment which has been accomplished to date in the area.

Reference to existing conditions in the area before agreements is represented by the summary of conservation survey data.

Before the plans were made on the 85 farms, 3,072.5 acres or 37 percent of their farm acreage was used as cropland. Today, 1,749.95 acres, 22 percent, is used as cropland on these farms. See Figure 32.

Practically all acreage which would otherwise be bare through winter is now protected by winter cover crops. This acreage, in addition to cover provided in rotations, furnished winter protection for 99 percent of all cropland.

Rotations on farms before planning were very indefinite as a rule. Today, all cropland is farmed under rotations approved as satisfactory for erosion control.

As is shown in Figure 32, 33 percent of the land on cooperating farms was in pasture before planning. After 3 years, 34 percent of the land is in pasture. Although approximately 500 acres of cropland were converted to pasture, 310 acres of pasture were converted to woodland.

Contour furrows were constructed on 50 acres of pasture in establishment and renovation of old pastures. None were in use before planning.

Permanent meadow is planned for 973 acres as compared with 133 acres before. This type of meadow consists largely of alfalfa-grass mixture.

Areas for wildlife use were designated on 39 acres of formerly idle land.

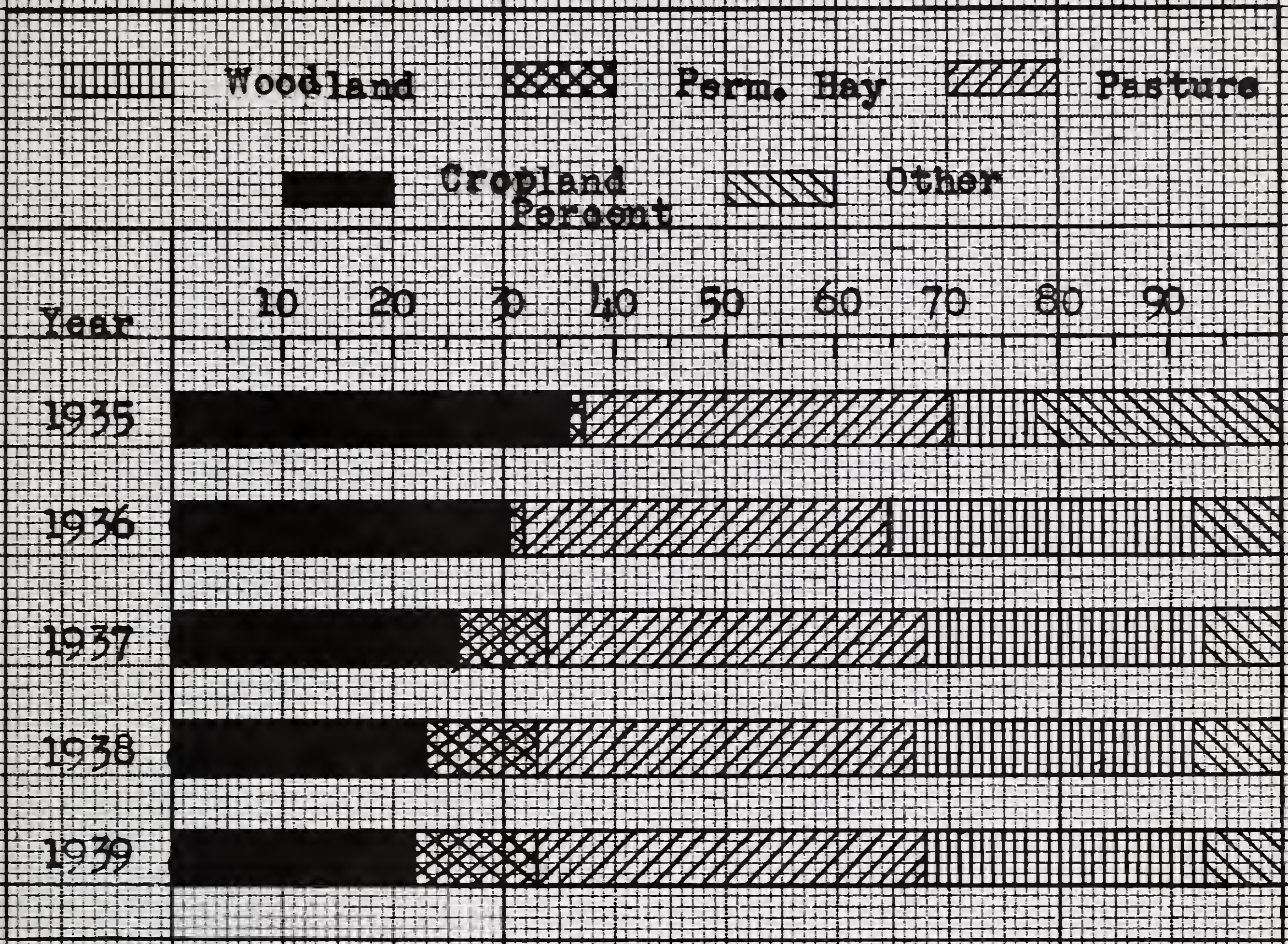

Figure 32. -- Land use changes on cooperator farms.

Woodland acreage was increased 18 percent, the major portion of which was converted from what was formerly other land and pasture. New planting for woodland was done on 160 acres.

Figure 33 shows the areas which were covered by cooperative agreement within the watershed. The effective value of any new method or practice may be gaged by public acceptance, after a demonstration of the economy and usefulness creates a desire for that thing. Farms on which soil conservation practices have been adopted by non-cooperators since the initiation of work on the demonstration farms are indicated by lines.

A summary and analysis of the physical data on soils, slopes and erosion, with associated land use and erosion control practices before planning and after planning, was made with the assistance of Mr. F. V. Smith of the Farm Management Division of Purdue University. This data was accumulated from 84 project agreements. In this summary, woods pastures, which are shown in agreements as other land, is included under pasture acreage.

In the appendix will be found data, showing relation between slopes and land use; erosion and land use, before and after planning. The association of contour stripping with soil types, slopes and erosion after planning, the changes in land use by slope groups, is shown.

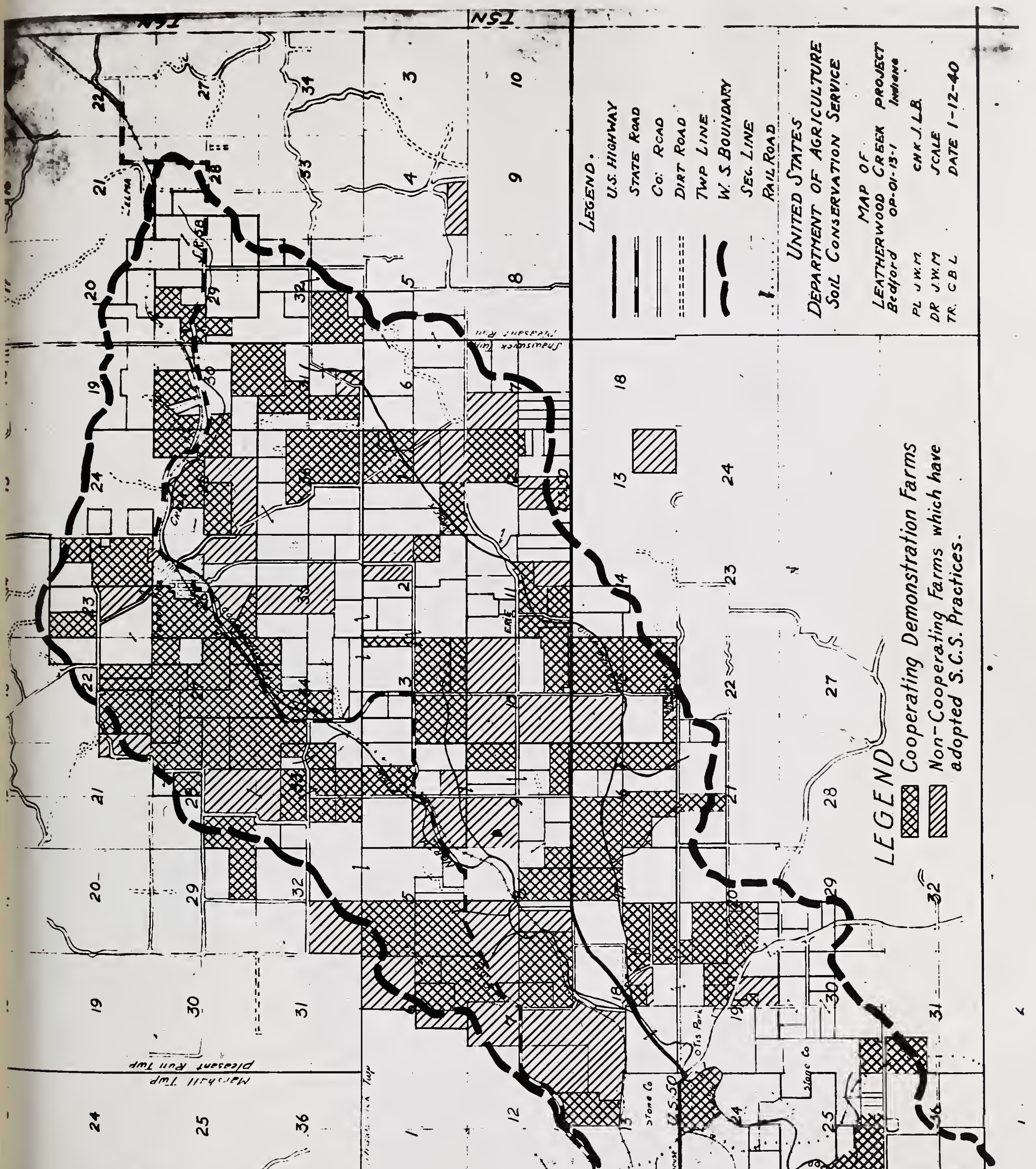
LEGEND.
U.S. HIGHWAY
STATE ROAD
CO. ROAD
DIRT ROAD
TWP LINE
W. S. BOUNDARY
SEC. LINE
RAIL ROAD
UNITED STATES
DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MAP OF
LEATHERWOOD CREEK PROJECT
Bedford OP-01-13-1 Indiana
PL J.W.M. CHK J.LB.
DR J.W.M SCALE
TR. CBL DATE 1-12-40
LEGEND
Cooperating Demonstration Farms
Non-Cooperating Farms which have adopted S.C.S. Practices.
Pleasant Run Twp
Marshall Twp
Shawswick Twp
U.S. 50
Otis Park
Stone Co

Figure 33.

Economic and Social

Cost of production studies on cooperating farms on this project show that 10 to 12 percent more time is required to perform the farming operations on the contour. This additional time, however, is balanced by increased yields on practically all of the important crops. In most cases heavier applications of soil amendments are being used, but the additional unit returns more than offset the extra expenditure for labor and materials.

Table 17 shows the average corn and hay yields on 15 cooperating farms for the past 4 years, and the increase above the 1933-35 average yields.

One reason why the program has been acceptable is the fact that no additional machinery, power, or labor have been necessary to execute it. In fact, many farms are operating with less labor because of a more even distribution of labor throughout the year.

The average number productive man work units per crop acre has been reduced approximately 13 percent during the period, as shown by records on 15 farms in 1936, 1937 and 1938. The total digestible nutrients per farm and per crop acre have increased about 29 percent during the period. This is an indication that the program has contributed to more efficient use of land and labor.

Table 17. Trend of corn and hay yields shown by records on 15 cooperating farms

	1933-35 Ave.		1936		1937		1938		1939	
	Corn Bu.	Hay Tons	Corn Bu.	Hay Tons	Corn Bu.	Hay Tons	Corn Bu.	Hay Tons	Corn Bu.	Hay Tons
	34.4	1.1	32.4	1	44.0	1.7	46.2	1.5	47.6	-
Increase	-	-	0	0	9.6	.6	11.8	.4	13.2	-
Percent increase	-	-	0	0	21.0	54.0	34.0	36.0	38.0	-

There has been very little shift in livestock since the beginning of the program, as shown by a recent survey. This is due principally to the fact that when adjustments were made in land use the crops produced and the livestock requirements were in a favorable balance both for erosion control and for most efficient feeding. The shifts in the type of livestock were very minor. In most cases the farms were over-stocked in relation to the types of feed produced.

In many cases the annual returns to the cooperators have increased as shown by 3 years of financial records kept by cooperators. Higher yields, more efficient feeding of livestock, higher quality feed, better quality livestock and production of lower cost feeds have all been contributing factors to the maintenance of income.

Improved living conditions are one measure by which to gage favorable results of the program. Observation has shown that many farms have new appliances in the home, some have purchased new cars, buildings have been painted, and fences improved. This is not true in all cases, but on the better demonstrations the cooperators report their farms are increasing in value each year due to the complete conservation program. Estimated increases in value over the 3-year period of agreement, according to the cooperators, range from 5 to 10 dollars per acre. Other factors which have been considered in the economy of soil conservation are shown in a report of farm management studies made by project technicians.

Costs of Establishment

Considerable labor, material and equipment were involved in the initiation and application of practices designed to control run-off and erosion.

The extent of contributions by farmer-cooperators and the Soil Conservation Service was determined largely by the fact that the program was demonstrational, educational and an emergency. Consequently, the Service contributed a large percent of the initial costs.

Unit costs of land use treatment and erosion control practices, the percent of the cost contributed by cooperators and government and the estimated cost for the farmer to do the work, are shown by data in the appendix, Summary of Unit Costs.

Tree planting, woodland improvement, farm pond costs were high due to type and inexperience of labor, development of methods of planting and other activities were slow.

UNSOLVED PROBLEMS

A great deal of knowledge has been gained from work and observation of results of establishing the program on this watershed but problems have come to our attention which have not been answered on account of lack of time and equipment. Some of the questions have arisen in other places and answers are being made daily.

erodibility

On this project the apparent difference in erosiveness of similar soil types derived from pure and impure limestone has not been explained. Bedford silt loam derived from impure limestone is more erosive.

The value and methods of providing more organic matter in soil as an erosion control practice is accepted but data is lacking as supporting evidence.

The establishment of meadows is a problem which has not been solved satisfactorily since work has been in progress here. This has resulted in disrupted rotations and less effective strip cropping.

The uses of forage are becoming a problem on farms where land use classes require a large percent of acreage in erosion resisting crops. Research should be done along this line.

Questions concerning the use and application of strips have occurred frequently. These problems are being solved by current research work.

Areas which should be in pasture present a problem in land use, if the area is inaccessible to water. Ponds are expensive and unsatisfactory in limestone areas, wells are frequently inadequate, springs are dry in time of most need.

What procedures are best to create a consciousness of the seriousness and necessity for control of erosion in the minds of farmers and the public -- and get action? Very often farmers will not apply the measures which they admit are necessary and effective for conservation farming. Evidence is needed badly in areas of this kind, to show the economy of soil conservation practices, or answers to the question, "What will it cost?"

APPENDIX

STANDARD SYMBOLS FOR LAND USE MAPS

A - Land removed from cultivation

===B====B==== Buffer strips (In exact location on contour)

F - New woodland planting

H - Wildlife work

L - Cultivated or rotation land

M - Permanent sod waterways

N - Grasses or perennial legumes for hay

O - Orchard

P - Pasture

W - Woodland, established timber, protected from grazing

WP - Woodland pasture

X - Idle land

Z - Miscellaneous crops, truck, etc.

■ Farm buildings, occupied

□ Farm buildings, unoccupied

School

Church

 Pond

3 6d Field numbers

3.4 Ac. - Field area

Public road

--------------------- Private road

----X-------X-------- Present permanent fence

----I-------I-------- New fence

----Y-------Y-------- Relocated fence

----O-------O-------- Old fence - to be removed

--------------------- Crop boundary - field division

----O----O-----O------- Crop boundary - to be removed

Farm boundary line

Table 18. Average number of personnel on project annually

Classification	Fiscal years				
	1935-36	1936-37	1937-38	1938-39	1939-40
Administrative	12	12	11	6	1
Technical	26	19	15	11	3
L.A.	0	13	4	2	0
W.P.A. man-days	2,200	13,600	2,435	500	0

Table 19. Degree of program establishment on demonstration farms

	Number of units	Percent	Acreage	Percent
Total project area requiring soil conservation treatment	240	100.0	23,751.57	100.0
Total farms and ranches in project area	240	100.0	25,028.00	100.0
Cooperative agreements signed	88	36.6	8,669.24	34.6
Cooperative agreements in force (1939-40)	85	35.4	8,476.24	97.7
Coordinated program established	77	90.0	7,670.55	90.0
Farms and ranches where post-agreement cooperation may be expected	66	78.0	6,544.05	77.0

Table 20. Land conversions on demonstration farms

Before agreement		After agreement					
		Cropland	Pasture or range	Permanent hay	Woodland wildlife	Orchard Vineyard	Other land
Cropland	3,072.50	1,749.95	497.90	781.05	23.3	4.00	16.30
Pasture	2,781.40	27.50	2,364.00	22.50	310.7	0	21.50
Permanent hay	133.70	0	3.00	130.70	0	0	0
Woodland and wildlife	624.80	0	0	0	624.8	0	0
Orchard and vineyard	46.15	0	3.20	2.50	2.8	37.65	0
Other land	1,817.69	23.8	88.20	36.30	1,138.0	0	531.39
Acres in agreement	8,476.24	1,801.25	2,991.50	973.05	2,099.6	41.65	569.19
Net changes		-1,271.25	+210.10	+839.35	+1,474.8	-4.5	-1,248.50

Table 21. Degree of practice establishment (85 cooperating farms)

	Unit	Potential amount	Actual amount	Percent accomplishment
Contour cultivation	Acres	1,339.15	1,239.95	99.4
Strip cropping	Acres	1,247.90	1,009.85	83.0
Terracing	Miles	.80	.80	100.0
Terraces	Ac.Prot.	10.00	10.00	100.0
Winter cover crops	Acres	36.15	42.30	117.0
Fertilized (new practice)	Acres	1,204.35	1,039.85	86.3
Approved rotations	Acres	1,830.95	1,664.25	90.8
Contour furrows or ridges	Acres	48.55	48.55	93.8
New pasture or range	Acres	519.30	516.30	99.4
Farm ponds	Number	5.00	5.00	100.0
Farm ponds	Ac.Ft.Stor.	1.12	1.12	100.0
Controlled grazing	Acres	2,248.80	2,071.70	92.1
Limed	Acres	2,490.70	2,210.90	88.7
Springs improved	Number	6.00	6.00	100.0
Pasture treatment	Acres	-	694.70	-
New permanent hay	Acres	768.60	686.50	89.3
Wildlife areas	Acres	38.90	38.90	100.0
New woodlands	Acres	163.70	160.70	98.1
Woodland protected	Acres	1,886.70	1,872.20	99.2
Mulched	Sq.Yds.	28,139.00	27,655.00	98.2
Diversion ditches	Lin.Ft.	2,751.00	2,751.00	100.0
New fences built to aid in erosion control	Rods	8,062.00	7,973.00	98.8
Fences relocated to aid in erosion control	Rods	2,209.50	2,198.00	99.4
Gully structures	Number	362.00	362.00	100.0
RESULTS OF PRACTICES				
Acres taken out of cultivation	Acres	1,359.00	1,246.10	91.6
Decrease in clean-tilled crops	Acres	619.00	611.21	98.6
Cropland winter protected	Acres	1,875.70	1,713.75	98.0

Table 22. Summary of accomplishments in erosion control demonstrations

		Potential acreage	Actual acreage treated	Percent accomplishment
Total project area requiring soil conservation treatment	C	8,242.60	8,242.60	100
	NC	15,508.97	3,141.78	20
Total	C & NC	23,751.57	11,384.38	47
Acreage in project not requiring soil conservation treatment		1,276.43		
Total gross acreage of project		25,028.00		

Table 23. Relation between slope and land use (before planning[1]) (84 farms)

Slope	Acres		Land use classes				
			Cropland	Meadow	Pasture	Woods	Miscellaneous
A	1,606.1	Acres	802.0	13.5	704.5	58.0	28.1
		Percent	50.0	.8	43.8	3.6	1.8
B	2,440.8	Acres	1,321.1	28.7	915.5	130.3	45.2
		Percent	54.1	1.2	37.5	5.3	1.9
BB	1,745.6	Acres	838.7	31.7	753.2	73.7	48.3
		Percent	48.0	1.8	43.2	4.2	2.8
C	1,013.4	Acres	278.0	14.5	575.3	42.0	103.6
		Percent	27.4	1.4	56.8	4.2	10.2
D	1,284.1	Acres	44.2	11.0	1,010.0	199.9	19.0
		Percent	3.4	.8	78.7	15.6	1.5
Total	8,090.0	Acres	3,284.0	99.4	3,958.5	503.9	244.2
		Percent	40.6	1.3	48.9	6.2	3.0

[1]Analysis by F. V. Smith, Farm Management, Purdue University.

Table 24. Relation between slope and land use (after planning[1]) (84 farms)

Slope	Acres		Land use classes				
			Cropland	Meadow	Pasture	Woods	Miscellaneous
A	1,606.1	Acres	546.7	190.1	566.1	281.5	21.7
		Percent	34.1	11.2	35.3	17.6	1.8
B	2,440.8	Acres	798.2	384.9	750.2	477.0	30.5
		Percent	32.7	15.8	30.7	19.5	1.3
BB	1,745.6	Acres	439.4	283.8	706.3	294.1	22.0
		Percent	25.2	16.3	40.5	16.8	1.2
C	1,013.4	Acres	86.9	106.6	535.6	233.3	51.0
		Percent	8.6	10.5	52.9	23.0	5.0
D	1,284.1	Acres	4.5	28.2	491.4	745.0	15.0
		Percent	.4	2.2	38.3	58.0	1.1
Total	8,090.0	Acres	1,875.7	993.6	3,049.6	2,030.9	140.2
		Percent	23.2	12.3	37.7	25.1	1.7

[1] Analysis by F. V. Smith, Farm Management, Purdue University.

Table 25. Relation between degree of erosion and land use (before planning) (84 farms)

Erosion groups	Acres	Land use classification									
		Cropland		Meadow		Pasture		Woods		Miscellaneous	
		Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
1	1,043.3	402.9	38.6	10.6	1.0	539.3	51.7	72.8	7.0	17.7	1.7
2	3,546.2	1,336.8	37.7	40.1	1.1	1,863.6	52.6	269.1	7.6	36.6	1.0
3	2,372.5	923.2	38.9	37.4	1.6	1,176.3	49.6	84.2	3.5	151.4	6.4
33	502.2	354.1	70.4	12.7	2.6	99.6	19.6	16.8	3.4	19.0	3.8
4	42.1	27.1	64.4	-	-	15.0	35.6	-	-	-	-
37	211.8	83.9	39.6	.5	.2	103.9	49.1	19.0	9.0	4.5	2.1
27	24.5	13.0	53.1	-	-	11.5	46.9	-	-	-	-
337	82.4	48.2	58.5	-	-	24.7	30.0	5.5	6.7	4.0	4.8
338	132.8	35.4	27.4	-	-	52.4	39.5	44.0	33.1	-	-
28	4.5	-	-	-	-	4.5	100.0	-	-	-	-
38	104.7	30.0	28.7	-	-	61.2	58.4	8.5	8.1	5.0	4.8
5	.5	-	-	-	-	.5	100.0	-	-	-	-
48	19.0	19.0	100.0	-	-	-	-	-	-	-	-
9	3.5	1.0	28.6	-	-	2.5	71.4	-	-	-	-
Total	8,090.0	3,275.6	40.5	101.3	1.2	3,955.0	49.0	519.9	6.4	238.2	2.9

Table 26. Relation between degree of erosion and land use (after planning) (84 farms)

Erosion Groups	Acres	Land use classification									
		Cropland		Meadow		Pasture		Woods		Miscellaneous	
		Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
1	1,043.3	298.6	28.6	101.1	9.7	344.5	33.0	281.9	27.0	17.2	1.7
2	3,546.2	823.1	23.2	376.4	10.6	1,239.5	35.0	1,089.7	30.7	17.5	.5
3	2,372.5	500.9	21.1	314.9	13.3	1,034.5	43.6	427.7	18.0	94.5	4.0
33	502.2	148.0	29.5	129.4	25.8	168.5	33.5	52.3	10.4	4.0	.8
4	42.1	6.4	15.2	5.5	13.1	19.7	46.8	10.5	24.9	-	-
37	211.8	46.9	22.1	24.0	11.3	86.8	41.0	54.1	25.6	-	-
27	24.5	11.0	44.9	-	-	12.5	51.0	1.0	4.1	-	-
337	82.4	11.7	14.2	19.6	23.8	31.6	38.3	19.5	23.7	-	-
338	132.8	6.4	4.8	12.5	9.4	51.9	39.1	62.0	46.7	-	-
28	4.5	-	-	-	-	4.5	100.0	-	-	-	-
38	104.7	-	-	8.0	7.7	43.7	41.7	46.0	43.9	7.0	6.7
5	.5	-	-	-	-	.5	100.0	-	-	-	-
48	19.0	-	-	4.0	21.1	15.0	78.9	-	-	-	-
9	3.5	-	-	-	-	-	-	3.5	100.0	-	-
Total	8,090.0	1,853.0	22.9	995.4	12.3	3,053.2	37.8	2,048.2	25.3	140.2	1.7

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Table 27. Relation between contour strip tillage, soil type, slope and erosion (84 farms)

Soil type[1]	Acres strip cropped	Slope groups					Erosion groups					
		A	B	BB	C	D	1	2	3	33	27 37	4 337 338
3	750.8	70.0	370.9	265.3	44.6	-	28.6	376.4	232.1	70.3	42.9	.5
4	854.8	75.6	418.2	305.0	56.0	-	28.7	384.0	311.3	83.7	41.9	5.2
6	154.8	5.5	49.0	76.6	23.7	-	4.5	56.1	63.2	17.0	14.0	-
9	66.0	2.0	50.0	13.0	1.0	-	2.0	51.0	10.0	-	3.0	-
Total	1,826.4	153.1	888.1	659.9	125.3	-	63.8	867.5	616.6	171.0	101.8	5.7
23	20.3	4.7	8.8	6.8	-	-	-	11.9	8.4	-	-	-
26	7.0	-	3.0	3.5	.5	-	-	5.0	.5	-	1.5	-
Total	27.3	4.7	11.8	10.3	.5	-	-	16.9	8.9	-	1.5	-
31	30.5	20.2	6.3	4.0	-	-	3.0	22.5	5.0	-	-	-
32	217.7	62.4	107.2	41.1	6.0	1.0	8.0	141.6	25.2	25.0	13.9	4.0
33	411.5	85.8	185.0	125.2	14.5	1.0	8.0	226.2	90.8	43.6	38.9	4.0
34	421.6	56.5	191.2	137.2	33.7	3.0	17.5	209.9	122.3	39.0	29.9	3.0
Total	1,081.3	224.9	489.7	307.5	54.2	5.0	36.5	600.2	243.3	107.6	82.7	11.0
42	6.7	2.7	-	4.0	-	-	-	2.7	-	-	-	4.0
43	6.7	2.7	-	4.0	-	-	-	2.7	-	-	-	4.0
Total	13.4	5.4	-	8.0	-	-	-	5.4	-	-	-	8.0
52	24.8	9.8	7.0	5.0	3.0	-	6.8	15.0	3.0	-	-	-
53	143.5	4.5	75.5	44.8	18.7	-	6.5	88.8	44.2	1.0	3.0	-
54	85.3	9.8	21.0	46.0	8.5	-	6.8	29.0	22.5	14.0	13.0	-
62	24.8	9.8	7.0	5.0	3.0	-	6.8	15.0	3.0	-	-	-
63	102.7	15.0	54.5	33.2	-	-	6.0	42.5	25.0	15.8	11.4	-
64	130.4	28.0	63.5	36.4	.5	2.0	10.0	52.0	31.0	26.0	11.4	-
Total	511.5	76.9	228.5	170.4	33.7	2.0	44.9	242.3	128.7	56.8	38.8	-
Total	3,459.9	465.0	1,618.1	1,156.1	213.7	7.0	145.2	1,732.3	997.5	335.4	224.8	24.7

[1] See legend page 34.

Table 28. Changes in land use by slope groups (84 farms)

Slope groups	Acres	Land use classification									
		Cropland		Meadow		Pasture		Woods		Miscellaneous	
		(1) before percent	(2) after percent	(1) before percent	(2) after percent	(1) before percent	(2) after percent	(1) before percent	(2) after percent	(1) before percent	(2) after percent
A (0-3%)	1,606.1	50.0	34.1	.8	11.2	43.8	35.3	3.6	17.6	1.8	1.8
B (3-8%)	2,440.8	54.1	32.7	1.2	15.8	37.5	30.7	5.3	19.5	1.9	1.3
BB (8-12%)	1,745.6	48.0	25.2	1.8	16.3	43.2	40.5	4.2	16.8	2.8	1.2
C (12-20%)	1,013.4	27.4	8.6	1.4	10.5	56.8	52.9	4.2	23.0	10.2	5.0
D (more than 20%)	1,284.1	3.4	.4	.8	2.2	78.7	38.3	15.6	58.0	1.5	1.1
Total	8,090.0	40.6	23.2	1.3	12.3	48.9	37.7	6.2	25.1	3.0	1.7

(1) Before soil conservation practices were put into effect.
(2) After soil conservation practices were put into effect.

Table 29. Summary of unit costs of practice establishment on 87 demonstration farms

	Unit	Quantity upon which unit cost is based	Total cost	Percent contributed by		Actual cost per unit	Estimated unit cost to operator
				Coop'r.	Gov't.		
LAND USE TREATMENT							
Cultivated	Acres	1,980.0	$ 7,112.00	36	64	$ 3.62	$ 3.50
Pasture	"	2,886.0	20,066.00	27	73	6.95	7.50
Permanent hay	"	847.0	12,654.00	56	44	14.94	12.00
Wildlife	"	85.0	617.00	8	92	7.26	5.00
Woodland	"	2,000.0	32,087.00	5	95	16.04	5.00
Orchard and vineyard	"	38.0					
Other land	"	521.0					
Total acreage treated	"	8,356.0	12,598.00	23	77	8.69	
PRACTICES							
Liming - cropland	"	1,036.0	3,833.00	55	45	3.70	3.70
Strip cropping, Est.	"	1,053.0	1,053.00	25	75	1.00	1.00
Cover crops, Est.	"	137.0	137.00	100	0	1.00	1.00
Woods improvement	"	433.0	14,494.00	0	100	33.45	15.00
Contour furrows or ridges	"	57.0	350.00	38	62	6.17	5.00
Planting new pasture or range land	"	433.0	2,824.00	63	37	6.53	8.00
Farm ponds	Ac.Ft.	1.6	1,491.00	21	79	932.20	
Planting permanent hay	Acres	847.0	9,544.00	73	27	11.27	
Planting wildlife areas	"	68.0	617.00	9	91	9.06	4.00
Planting trees	"	184.0	4,903.00	6	94	26.63	12.00
Pasture treatment	"	840.0	3,851.00	50	50	4.58	6.00
Gully control	"	1,212.0	7,991.00	3	97	6.59	
Diversions	Lin.Ft.	3,159.0	1,379.00	3	97	0.44	.06
New fence construction	Rods	10,340.0	18,061.00	14	86	1.75	
Spring improvement	No.	10.0	1,004.00	15	85	100.40	

Table 30. Data on informational activities, annual report

Activity		1936	1937	1938	1939
Visitors to project	No.	-	-	20	15
Farmers' meetings	No.	5	19	3	2
	Est. Att.	415	805	125	100
Farmer tours	No.	2	6	21	13
	Att.	140	292	572	352
Student tours	No.	0	0	1	1
	Att.	0	0	4	6
Movies	No.	-	-	2	5
	Att.	-	-	80	350
Other exhibits	No.	-	-	6	8
	Att.	-	-	250	400
Radio talks	No.	0	3	2	2
Newspapers	No.	2	2	2	2
	Ave. Circ.	4,400	4,400	4,400	4,400
Press releases	No.	9	20	30	10
Sign marked highway	Mi.	0	0	10	10
Daily auto traffic	No.	1,500	1,500	-	-

Table 31. Man work units expended and total digestible nutrients produced[1]. D. A. Ritchie farm

	1936	1937	1938
Average crop acres per farm	63.50	59.60	60.30
Average productive man work units on crops per farm	122.00	98.00	101.00
Average man work units per 100 acres	87.00	70.00	72.00
Average man work units per crop acre	1.92	1.66	1.67
Average total digestible nutrients produced on crop acre per farm	73,931.00	90,365.00	90,904.00
Total digestible nutrients per crop acre per farm	1,160.00	1,510.00	1,500.00

[1]Calculated from data compiled by Farm Management Department, Purdue University.

Table 32. Important factors of the farm business. Ritchie farm account records[1]

Year	L.S. Rec. per tillable acre	L.S. Rec. /$1.00 feed fed[2]	Value crops per tillable acre	L.S. efficiency index[3]	M. W. U.[4]		Op. expense per tillable acre	L.P.M. cost per crop ac.[5]	Crop yield index[6]
					crop	livestock			
1936	32.47	1.97	12.88	162	148	293	17	9.37	72
1937	28.42	1.79	12.81	119	130	386	21	12.44	93
1938	32.55	2.38	11.58	171	116	266	20	12.63	95

[1]Summary and analysis by Farm Management Department. Purdue University.

[2]Total net increase from all livestock divided by total value of all feed fed.

[3]Livestock receipts per $1.00 worth of feed fed weighted by the kind of livestock fed.

[4]Man work units -- number of 10-hour days of work on crops and livestock available, using average rates for doing work.

[5]Total labor, power and machinery costs divided by total crop acres.

[6]Percentage of average yield of all crops on the farm as compared to the area.

Table 33. Location Indiana SCS camps administratively attached to project

Year				
1935-36	1936-37	1937-38	1938-39	1939-40
Princeton	Princeton	Princeton	Princeton	No camps
Lafayette	Lexington	Lexington	Lexington	
Waveland	Wadesville	Wadesville	Wadesville	
Brookville	North Vernon	Salem	Washington	
Lexington	Salem	Washington	Worthington	
Wadesville	Washington	Worthington		
Bedford	Worthington			
North Vernon				
Salem				
Huntington				
Washington				
Bloomington				
Rising Sun				
Worthington				

SPECIAL PASTURE STUDY TABLES

Table 34. Amount of dry matter produced per acre of pasture, by farms. Special pasture study

Farm number	Treated pasture			Untreated pasture			Sup.[1] pasture		
	1939 acres	1938 D.M.[2] Lbs.	1939 D.M. Lbs.	1939 acres	1938 D.M. Lbs.	1939 D.M. Lbs.	1939 acres	1938 D.M. Lbs.	1939 D.M. Lbs.
1	6.0	1,538.0	1,875.00	24.5	1,086	1,344.00	48.6	399	277.50
2	16.0	-	2,447.50	18.0	-	1,036.70	21.5	-	398.75
3	10.0	1,953.7	1,436.25	14.5	1,050	407.75	15.1	158	455.00
4	5.0	1,934.0	1,952.50	7.0	1,350	770.00	0	0	0
5	9.8	-	1,877.50	13.5	-	1,463.00	39.9	-	1,077.75
6	13.0	-	1,629.00	45.0	-	1,397.50	27.0	-	542.50
7	5.5	1,259.5	2,324.50	54.8	823	983.50	22.0	-	1,527.25
8	17.0	1,481.0	1,989.50	48.5	983	1,138.25	25.0	-	1,466.25
9	26.1	-	2,358.00	30.0	-	1,254.00	0	0	0
10	5.0	980.0	2,447.50	64.0	783	663.75	0	1,094	0
11	8.8	-	525.00	53.0	-	1,309.00	10.6	-	962.25
12	47.1	-	1,885.75	6.0	-	687.50	8.3	-	1,445.75

[1] Sup. - Supplementary

[2] D.M. - Dry matter

Table 35. Animal unit days of grazing per acre of treated, untreated and supplementary pasture for the years 1938 and 1939, by farm. Special pasture study

Farm number	Treated pasture			Untreated pasture			Sup.[1] pasture		
	1939 acres	1938 A.U.[2] days	1939 A.U. days	1939 acres	1938 A.U. days	1939 A.U. days	1939 acres	1938 A.U. days	1939 A.U. days
1	6.0	70.30	75.00	24.5	49.40	53.70	48.6	18.2	9.10
2	16.0	-	97.90	18.0	-	41.47	21.5	-	15.95
3	10.0	78.15	57.45	14.5	42.00	16.31	15.1	7.2	18.20
4	5.0	88.00	78.10	7.0	62.00	30.80	0	0	0
5	9.8	-	75.10	13.5	-	58.62	39.9	-	43.11
6	13.0	-	65.16	45.8	-	55.90	27.0	-	21.70
7	5.5	50.38	92.98	54.8	37.60	39.34	22.0	-	61.09
8	17.0	68.00	79.58	48.5	39.32	45.53	25.9	-	58.65
9	26.1	-	94.32	30.0	-	50.16	0	0	0
10	5.0	45.00	97.90	64.0	31.72	26.55	0	50.0	0
11	8.8	-	21.00	33.0	-	52.36	10.6	-	38.49
12	47.1	-	75.43	6.0	-	27.50	8.3	-	57.83

[1]Sup. - Supplementary

[2]A.U. - Animal unit

The above pastures were limed, fertilized and seeded in the spring of 1937 and 1938 excepting number 6 which was fertilized in the fall of 1937.

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Table 36. Range in animal unit days, pounds dry matter and value per acre in 1938 and 1939 for all 12 pastures. Special pasture study

Type pasture	Acres per A.U.	A.U. days per acre	Dry matter lbs. per acre	Value per acre $0.016/lb.D.M.
1938 treated	2.0 - 4.0	45.0-88	980 -1953.7	$15.68 - 30.94
1938 untreated	2.9 - 5.6	31.7-62	793 -1350.0	12.68 - 21.6
1938 supplementary	9.8 -25.0	7.2-18.2	399 -1094.0	2.53 - 17.5
1939 treated	1.84- 8.5	21.0-97.9	525 -2447.5	8.40 - 39.16
1939 untreated	3.07-11.0	16.3-58.5	407.7-1463.0	6.25 - 23.41
1939 supplementary	2.9 -19.7	9.1-61.0	227.5-1527.0	3.64 - 24.44

Table 37. Cost of treatment per acre of permanent pasture. Special pasture study

Farm No.	Acres	Amount	Cost	Amount	Cost	Amount	Lbs.	Cost	Total cost
		Tons							
1	6.0	1.5	$1.87	200# 0-20-0	$3.63	Sw. clover Alfalfa Orchard grass Alsike clover K. lespedeza	4.0 5.5 4.5 2.5 5.5	$2.60	$8.10
2	16.0	1.8	2.26	170# 0-20-0	2.11	Alsike clover K. lespedeza Red clover Alfalfa Timothy Redtop	1.8 3.1 1.7 1.6 2.8 1.0	1.75	6.12
3	10.0	2.0	2.50	400# 0-20-0	5.00	Ky. bluegrass K. lespedeza	3 5	.90	8.40
4	5.0	2.0	2.50	400# 0-20-0 400# 0-14-6	5.30				7.80
5	9.8	2.0	2.50	300# 0-20-0	3.75				6.25
6	13.0			300# 0-20-0	3.75	Redtop Timothy K. lespedeza	3 3 2	.78	4.53
7	5.5	2.0	2.50	400# 0-20-0	5.00	Timothy Redtop Ky. bluegrass Sw.clover Alsike clover W. clover Sw. clover Alsike clover	3 3 3 3 2 0.5 6 3	3.16	10.66
8	17.0	2.0	2.50	400# 0-20-0	5.00	Redtop Timothy Lespedeza Alsike	5 5 5 2	1.70	9.20
9	26.1	2.0 3.0	3.25	300# 0-20-0 200# 0-20-0	4.56	Sw. clover Alsike Orchard grass Redtop Timothy	6 2 5 2 4	2.52	10.33
10	5.0	2.0	2.50	400# 0-20-0	5.00	Alsike clover	3	.60	8.10
11	8.8	1.6	2.00	225# 0-20-0	2.81	Sw. clover Alfalfa K. lespedeza	2.3 2 2	.79	5.60
12	47.1	1.4	1.75	250# 0-20-0	3.12	Sw. clover Alsike clover Orchard grass Redtop Alfalfa	8 3 4 2 4	3.28	8.15

Table 38. Value of forage produced per acre based on dry matter. Special pasture study

Farm number	Treated pasture			Untreated pasture			Sup.[1] pasture		
	1939 acres	1938 value	1939 value	1939 acres	1938 value	1939 value	1939 acres	1938 value	1939 value
1	6.0	$24.63	$30.00	24.5	$17.31	$21.50	48.6	$ 6.38	$ 3.64
2	16.0	-	39.16	18.0	-	16.58	21.5	-	6.38
3	10.0	31.26	22.98	14.5	16.80	6.25	15.1	2.53	7.28
4	5.0	30.94	31.24	7.0	21.60	12.32	0	0	0
5	9.8	-	30.04	13.5	-	23.41	39.9	-	17.24
6	13.0	-	26.06	45.8	-	22.36	27.0	-	8.68
7	5.5	20.15	37.19	54.8	13.16	15.73	22.0	-	24.44
8	17.0	23.70	31.83	48.5	15.72	18.21	25.9	-	23.46
9	26.1	-	37.72	30.0	-	20.06	0	0	0
10	5.0	15.68	39.16	64.0	12.68	10.62	0	17.50	0
11	8.8	-	8.40	33.0	-	20.94	10.6	-	15.39
12	47.1	-	30.17	6.0	-	11.00	8.3	-	23.13

[1]Sup. - Supplementary

[illegible]

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LAND USE CAPABILITY TABLES AND RECOMMENDATIONS

Table 39. Land use capability, Bedford project

Soil or Soil Group	Slope	Erosion classes	Erosion Group	Land use capability I	II	III	IV	V
SOIL GROUP 1 Intermediate to well-drained upland.	A 0-3%	1,2	slight	X				
Normal "B" development		3,37	moderate		X			
Residual from limestone	B 3-8%	2	slight		X			
Bedford, Dunmore[1], Hagerstown silt loams		3,37,38, 33,337	moderate			X		
Intermediately drained terrace-residual sandstone and shale		338,47,48	severe				X	
Tilsit silt loam, valley phase	BB 8-12%	2	slight		X			
		3,37,38, 33,337	moderate			X		
		338,4	severe				X	
		47,48, 9	severe to very severe					X
	C 12-20%	2	slight			X		
		3,37,33, 337,38	moderate				X	
		338,4,47, 48,9	severe to very severe					X
	D 20%up	2	slight				X	
		all classes	moderate to very severe					X

[1]Dunmore silt loam on BB slope -- erosion 3,37,33,337 - has capability 4.

BB slope -- erosion 38,338,4 and C slope 38 erosion -- capability 5.

Erosion classes were taken from planimeter data.
Classes having very small acreage were omitted.

Cont.

Table 39. Cont.

SOIL GROUP 2 Imperfectly drained light colored soils, clay pan developed	A-B	1,2	slight		X			
Upland soils, Guthrie and Lawrence silt loams.	A-B	27,3	moderate			X		
Second bottom or terrace soils, McGary and Monongahela silt loams.								
SOIL GROUP 3 Deep, windblown soil	A-B	2	slight	X				
Princeton sandy loam	BB 8-12%	2 3	slight to moderate		X			
	C 12-20%	2 3	slight to moderate			X		
	D 20%up	2 3	slight to moderate				X	
SOIL GROUP 4 Shallow soils less than 40 inches to rock, well drained, derived from limestone	BB 8-12%	2,3,37 33	slight to moderate				X	
Hagerstown silt loam, shallow phase.	C 12-20%	2,3,33	slight moderate				X	
Hagerstown stony silt loam	D 20%up	2,3,37, 33,338	slight moderate					X
Residual from sandstone and shale. Muskingum silt loam.								

Cont.

Table 39. Cont.

SOIL GROUP 5 First bottom or alluvial soils.	A 0-3%	/,1,2	slight	X					
Huntington) all Linside) textures	B 3-8%	2	slight		X				
Sweet soils.									

Table 40. Land use capability classes and recommendations

Soil Group Characteristics						
Intermediate to well-drained upland soils. Normal "B" development. Residual from limestone. Bedford, Dunmore, Hagerstown silt loams. Intermediately drained terrace - residual sandstone and shale. Tilsit silt loam, valley phase.						
L.U. Capability Class	Slope	Erosion	Recommendations			
			Priority of use	Rotation	Special Practices	Fertility Practices and Soil Amendments
I	0-3%	slight	cropland	RGMM RGM	None	Lime according to test. Fertilizer, see table. Return crop residues and barnyard manure. Use winter cover crops and plow under green manures.
II	0-3% 3-8% 8-12%	moderate slight	1.cropland 2.grassland a.meadow	RGMM RGMMM	Contour cultivation up to 5% slope. Contour strip cropping above 5%. Sod waterways.	Same as above for cropland. Fertilizers for meadows, see table.
III	3-8% 8-12% 12-20%	moderate slight	1.cropland 2.grassland a.meadow b.pasture	RGMM RGMMM	Contour strips, diversion ditches, sod waterways	Same as above. Reseeding pastures to drouth resistant legumes.

Table 40. Land use capability classes and recommendations

Soil Group Characteristics

Intermediate to well-drained upland soils. Normal "B" development. Residual from limestone. Bedford, Dunmore, Hagerstown silt loams. Intermediately drained terrace - residual sandstone and shale. Tilsit silt loam, valley phase

L.U. Capability Class	Slope	Erosion	Priority of use	Rotation	Special Practices	Fertility Practices and Soil Amendments
IV	3-8% 12-20% 20% up	severe moderate slight	1.grassland a.pasture b.meadow 2.woodland and/or wildlife		Pasture treatment. Alternate grazing, mowing, and contour furrows in pasture, grazing control. Diversion ditches. Woodland and wildlife areas-protection and management	Lime according to test. Fertilizer, 400# to 600# 0-20-0 on pastures. Fertilizers for meadows, see table. Fertilize and mulch plantings. Reseeding pasture to drought resistant legumes.
V	8-12% 12-20% 20% up	Severe to very severe moderate to very severe	1.woodland and/or wildlife 2.grassland a.pasture		Same as IV above	Same as IV above.

Table 40. Land use capability classes and recommendations

Soil Group Characteristics

Imperfectly drained light colored soils, clay pan developed. Upland soils, Guthrie and Lawrence silt loams. Second bottom or terrace soils, McGary and Monongahela silt loams.

L. U. Capability Class	Slope	Erosion	Recommendations			
			Priority of use	Rotation	Special Practices	Fertility Practices and Soil Amendments
II	0-3% 3-8%	slight	1.cropland 2.grassland a.meadow b.pasture	RGM RGMM	Needs additional drainage Contour cultivation	Lime according to test. Fertilizers, see table. Return crop residues and barnyard manure. Use winter cover crops and plow under green manures. Reseeding pastures to drouth resistant legumes.
III	0-3% 3-8%	moderate	1.cropland 2.grassland a.meadow b.pasture 3.woodland and/or wildlife	RGMM RGMMM	Contour strip cropping. Diversion ditches	Same as above for cropland. Fertilizers for meadows, see table. Pasture - 400# to 600# 0-14-6 per acre. Two tons of limestone per acre. Reseeding pastures to drouth resistant legumes.

Table 40. Land use capability classes and recommendations

Soil Group Characteristics						
Deep, windblown loessial soils. Princeton sandy loam.						
L. U. Capability Class	Slope	Erosion	Recommendations			
			Priority of use	Rotation	Special Practices	Fertility Practices and Soil Amendments
I	0-3%	slight	cropland	RGM RGMM	None	Lime according to test. Return crop residues and barnyard manure. Use winter cover crops and plow under green manures. Crop and meadow fertilizers, see table.
II	8-12%	slight to moderate	1.cropland 2.grassland a.meadow	RGMM or GMM	Contour cultivation	do.
III	12-20%	slight to moderate	1.cropland 2.grassland a.meadow b.pasture	RGMM or GMM	Contour strip cropping, sod waterways	do. Reseeding pastures to drouth resistant legumes.
IV	20% up	slight to moderate	1.grassland a.pasture 2.woodland and/or wildlife		Pasture treatment. Alternate grazing, mowing, grazing control. Woodland and wildlife areas, protection and management.	do. Pasture - 400# 0-14-6 per acre. One ton limestone per acre.

Table 40. Land use capability classes and recommendations

Soil Group Characteristics						
Shallow soils less than 40 inches to rock, well-drained, derived from limestone. Hagerstown silt loam, shallow phase. Hagerstown stony silt loam. Residual from sandstone and shale. Muskingum silt loam						
L. U. Capability Class	Slope	Erosion	Recommendations			
			Priority of use	Rotation	Special Practices	Fertility Practices and Soil Amendments
IV	8-12% 12-20%	slight to moderate	1.grassland a.pasture 2.woodland and/or wildlife		Pasture treatment. Mowing, alternate grazing, controlled grazing, woodland and/or wildlife protection and management	Lime, 1 to 2 tons. Fertilizer, 400# to 600# 0-20-0, manure. Reseeding pastures to drouth resistant legumes.
V	20% up	slight to moderate	Woodland and/or wildlife		Woodland and/or wildlife protection and management	Mulch and fertilize new locust plantings.

Table 40. Land use capability classes and recommendations

Soil Group Characteristics						
First bottom or alluvial soils. Huntington) Linside) all textures. Sweet soils.						
L.U. Capability Class	Slope	Erosion	Recommendations			
			Priority of use	Rotation	Special Practices	Fertility Practices and Soil Amendments
I	0-3%	slight	cropland	RG RR	Where there is occasional overflow. Where there is frequent overflow.	Legume inter-crop. Return crop residues. Plow down green manure crops.
II	3-8%	slight	1.cropland 2.grassland a.meadow	RGM	Diversion ditches at base of slopes.	Same as above. Fertilizers, see table.

Table 41. Fertilizer recommendations for field crops in Indiana

Soil	Soil Tests		Corn[2]				Wheat, rye and barley[3]		Spring grains seeded to legumes or alfalfa	
			Manured or covered		No manure or cover					
	Available P_2O_5	Available K_2O	Analysis	Lbs. per acre	Analysis	Lbs. per acre	Analysis	Lbs. per acre	Analysis	Lbs. per acre
a. Light colored sandy soils	Low	Low	0-12-12	125	(1)		3-12-12	200	0-12-12	300
	Low	High	0-14-6	125	(1)		2-12-6	200	0-20-0	300
	High	Low	0-10-20	125	(1)		3-12-12	200	0-8-24	300
b. "Gray flats" soils, poorly drained subsoil	Low	Low	0-12-12	150	0-12-12	200	3-12-12	300	(1)	
	Low	High	0-14-6	150	0-14-6	200	2-12-6	300	(1)	
	High	Low	0-10-20	150	0-10-20	200	3-12-12	300	(1)	
c. Light colored, medium to heavy soils, well drained	Low	Low	0-14-6	200	0-12-12	150	2-12-6	300	0-12-12	300
	Low	High	0-20-0	150	0-20-0	150	2-12-6	300	0-20-0	300
	High	Low	0-12-12	200	0-10-20	200	3-12-12	300	0-10-20	300

a. - The loessial soils similar to this group.
b. - The imperfectly drained soils similar to this group.
c. - The well drained silt loams similar to this group.

1. Such land not adapted to this crop.
2. When fertilizer is applied in the hill use one-half the amounts indicated.
3. On light colored sandy soils and in seasons following wet summers on other soils broadcast a spring top-dressing of 15 to 20 pounds nitrogen per acre on fall sown grain.

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